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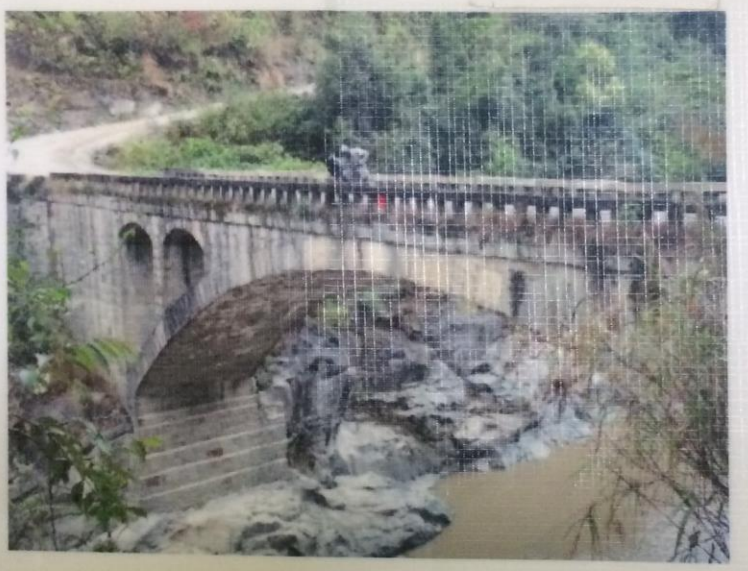
The Republic of the Union of Myanmar

Ngaw Chang Hka, Tongxinqiao Hydropower Project

Environmental and Social Impacts Assessment Report (FINAL)



YEIG 云南能投 YUNNAN ENERGY INVESTMENT
云南能投对外能源开发有限公司 YEIG INTERNATIONAL ENERGY DEVELOPMENT CO.,LTD.

中国电建 POWERCHINA 昆明勘测设计研究院有限公司 KUNMING ENGINEERING CORPORATION LIMITED

Resource & Environment Myanmar Ltd.

August 2016

Modifying specification

We revised the report carefully according to the comments. It is put forward at the editing location (Page) in the table below. And some revised parts about the contents except the comments are also done. For example, it is added the FS process and newly ESIA review process , the profile of the project and some project's contents in the Summary. And some modifying item on social problem is shown in the SIA report as the second part.

No.	Survey	Suggestions	Explanation	Page No.
1	**Project Description, Environmental conditions and Baseline Data**			
a	• The detail explanation of project objections and trend are express in page 21 to 25. • Project description and procedure are express in page 49 to 70 with layout pictures. • Conditions of physical environment, Ecology and Human Community Health Safety are express in page 71 to 114. • There will have Waste Management Plan concerning waste from construction and operational period, can see in page 144 to 145.			
b	• In page 68 to 69, did not express land area for the whole project, units of the land area are incorrect, didn't express the type of land about project area, furthermore no mention about that land has authority or not under the management of Department of Forestry and there has not expressed requirement of approval of the appropriate department.	• Land area for the whole project have to be mentioned with map for each business. • There will need to amend the units of the land area. • Resettlement detail plan expressed in Social Impact Assessment Report Plan, Chapter (7) Resettlement Action Plan, pages from 63 to 69 but have to need detail mentioning. • Need to express that project land is or not the authority of Department of Forestry and have to mention permit of appropriate department. • According to the location of project and type of land there will need to get permit. • Need to express references number with map for the applied area within project area and logistic area.	• • It is added in the main text. • It is added to the planning of NgaMaozut resettlement site , includes traffic planning, vertical planning, landscape planning, water supply and drainage planning, power supply planning. Planning for water and power supply and traffic outside village. • As to the landuse permission, it will be solved by the developer and relevant authority. And the developer's commitment letter is shown in the EIA	Page 61 page 63-65 of the SIA report page 52 of the SIA report

			report.	
c	• There didn't mention of surrounding environmental situations about applied land, mine and tunnel.	• Need to express residential area, destructive cultivated land area, and confiscable farmland area. • Only included size and location in Chapter (4.6.3.2) Headrace Tunnel, (4.6.4,) Construction Planning and (4.6.4.2) Quarry. Thus need to mention the surrounding environmental situations about applied land, mine and tunnel	• It is expressed in SIA • Considering the introduction of the environmental status of the whole project, we added a brief specification on the environmental situation of headrace in section 4.6.3.2/(2), others in the appendix 2, working photos.	• • • Page 56-57, 60
D	• There didn't mention about construction of tunnel it has 9600 meter long and related work program such as road construction and use of machinery	• Need to express about construction of tunnel it has 9600 meter long and related work program such as road construction and use of machinery. • In chapter (4.3.6.2) Headrace Tunnel, mentioned size of tunnel and will be construction. Thus should be mentioned impact of environmental conditions and mitigation plan.	• Added in section 4.6.6 • Analyse the impacts in detail in section 6.2.14 and the measures in section 6.3.1（5）	• Page 64-67 • Page 152-156 •
E	• Although express the policy and institutional frame work in page 26 to 41, there had not referred related enacted laws about project.	• In Chapter (3) Policy, Legal and Institutional Framework, Table (3.1.1) The existing Myanmar laws relating to environment, described enacted laws since some are not match for the proposed project. Thus need to describe the appropriate laws relating with the proposed project and have to expose the project proponent will be adhered that laws. • Need to describe the following laws. ○ Land Acquisition Act (1894) ○ Upper Myanmar Land and Revenue Regulation (1898) ○ Town and Village Land Act (1876) ○ Ward/Village tract administrative law (2012) ○ Environmental Conservation Laws (2012)/ Environmental Conservation Rules (2014) ○ Foreign Investment Law (（2012) ○ The Electricity Law (2015) ○ The Conservation of Water Resources and River Law (2006) ○ Social Security Law (2011) ○ Workmen's Compensation Act (1922) ○ The Minimum Wages Law (2013) ○ The Development of Employment and Expertise Law (2013)- ○ The Leave and Holiday Act (1951) ○ Labor Organization Law (2011) ○ Settlement of Labor Dispute Law	• Give the brief explanation, especially the contents on the Project.	• Page 31-34

	○ The Control of Smoking and Consumption of Tobacco Product Law 2006 ○ The Conservation of Cultural Heritage Objects Law (2015) ○ Motor Vehicles Law (2015) ○ Export and Import Law (2015) ○ Myanmar Engineer Council Law (2013) ○ Myanmar Architect Council Law (2014) ○ Myanmar Fire Forces Law (2015) ○ The Prevention the dangers of Hazardous Chemical and Related Substances Law (2013) (if the project will use this materials) ○ Related Laws enacted by Shan State Parliament		
• On construction stage will be needed a lot of cement, iron and mechanism but did not describe about the locations of that materials will get from. And also did not describe the procedure of trading/ customs if those will pass from borderline	• Make up for a deficiency about those data.	• Add in the section 4.6.6(2)	• Page 65 •
• In chapter (6.2.1.3),page 119,although described about the average numbers of construction labors will have from 1500 to 1950 during 45 months of constructional period since did not expose the number of assign workers concerning local able workers, borderland workers, able men especially numbers of staff during operational period.	• Need to describe numbers of assign local workers, able workers and borderline workers and must be described whose will follow rules and regulations of Immigration Department. And need to describe Workers' Accommodation for staff during constructional period and operational period. • Concerning future workers within proposed project, local workers and able workers might be assigned accordingly foreign investment laws.	• Add in the section 4.6.6(3)	• Page 66 •
• Data of traditional culture did not include. • In the page 111 of Chapter (5.5.5) Minerals, Cultural Relics and Historic Sites it mentioned Minerals, Cultural and Historic Sites did not find.	• Might be added the data of traditional culture.	• Prepare an individual paragraph to describe it by REM.	• Page 116 and Appendix 5
• Testing about water quality that had different names in parameters (table 5.2.2) and testing result (table 5.6.1).Did not include units. (see page 76 and 113)	• Have to describe Lab Result Verification that was tested in the acknowledge laboratory and might be reviewed the data. • Might be mentioned Lab result detail. • For Chapter (3.4) Proposed guideline and standards in the report, mentioned guideline and standard for the proposed project thus might be mentioned target values for the proposed project.	• It was implemented by the acknowledge laboratory and the monitoring results in appendix. • It is added	• appendix 6 • page 43
• Although described geology map of the project surrounding area in (page 82-91) did not include Drill hole location map, cross section.	• Earthquake caused sometimes in this area since might be describe suggestions and approvals of professional Engineer/PE, Geotechnical Engineer that the design data are safety and assure.	• The results in the report are done by the engineers from KHIDI and REM, it has been checked and reviewed by the MOEP reviewers.	• Appendix 9
• Project area is located in the Gneiss formation.	• Thus have to describe with cross-section, measurements, results and should be described observation report with signature of geological principal consultant Dr. Thiha Soe who is from Resource	• It has been prepared by the Dr. Thiha Soe.	• Appendix 9

		and Environment Myanmar (REM) Company.		
	• Concerning Soil and Sediment in Chapter (5.3.7) described only sediment.	• Concerning Soil and Sediment should be more described assessment of sediment and also have to include Remediation plan about it.	• It is added the detailed assessment.	• Page 139-140
	• It did not mention the Impact Assessment and Mitigation Measures in chapter (6) about remainder physical conditions of surrounding project area after finishing the process.	• It should be described hydrology situation after construction of four dams furthermore relate effected and oddment effected with detail descriptions.	• Considering the upstream projects are all run-of –river hydropower project, it will only affect the hydrology situation from dam to the powerhouse but it will not be a cumulative impact on the hydrology.	• Page 183-184
	• It did not describe the term of project and schedule of closing stage.	• The term of project and the schedule after closing stage should be mentioned.	• 4.6.4.10 (2)	• Page 63
	Analyst and specify for the Impacts			
	• Impacts of Physical, Biology and Socio-economic can see in chapter (6), Impact Assessment and Mitigation Measures and relate effected can see in Chapter (8), Cumulative Impact Assessment.	• For Cumulative Impact should be described in more detail. • In preliminary stage, construction stage, operation stage, closing stage and after closing stage, each stage should be carried out impacts of climate changes such as emission of Greenhouse gases, mitigation be in a mass of Carbon and impacts assessment of physical and biological such as social, socio-economic, health, cultural and scenery. And also carried out mitigation management plan and measurement of oddment affected.	• It is described in section 8.5, the whole paragrapth. • Seeing in section 6.2.12 and 6.2.13.	• Page 150-152
	• Report did not mention map of affected area due to proposed project.	Map of affected area due to proposed project should be mentioned.	• The affected area main involve project occupied land and working individuals affected in daily life. It is included in the assessment area.	• In figure 6.1-1.
	• Impacts on the outside of proposed project area are not considerations. Especially did not mention such as cumulative impacts on May Kha River due to the construction of Dam and social impacts along the Ngwe Chan Kha River furthermore sensitive area and relating climate changes. (page 157 – 164)	• Impacts on the outside of proposed project area, possible impacts on May Kha river and social impacts in Ngwe Chan Kha river have to mention. • In Chapter (8) (8.5.4) that only mentioned positive impacts on social environment and did not mention negative impacts thus it might be mentioned. (• For possible affected on original sensitive regions and residential area should be mentioned by appropriate proportion with related maps, photos, sky photos and satellite photos.	• It mainly impacts the social aspects outside the porposed area in section 6.2.3.4. • Seeing 8.5.4(5) • It is added to a drawing about the NgaMaozut village's current status. Drawing 1 Land Acquisition Area of Tongxinqiao HPP; Drawing 2 Overall planning Drawing for NgaMaozut Resettlement	• Page 134-138 • Page 189 • drawi s 1~7, page 83 SIA report

			of Tongxinqiao HPP; Drawing 6 Status Quo for NgaMaozut village of Tongxinqiao HPP, etc.	
D	• Did not mention estimated calculation of removing outer soil and biomass, factory construction and tunnel construction due to the Dam construction and digging the rocks. (page 64-68)	• Might be mentioned the impacts due to Dam construction, digging the rocks, factory construction and tunnel construction.	• Seeing in the section 6.2.2.4 and 6.2.6	• Page 132-139
E	• Possibility impacts due to minefield two areas, concrete factories two areas and concrete maker factories did not include.(page 66-67)	• Might be mentioned impacts due to two quarry areas, two concrete factories areas and concrete maker factories. • Mitigation schedules should be include in the mitigation measures and environmental management plan.	• Adding in the section 6.2.14. • Seeing in the section 9.3.7	• Page 152-153 • Page 202
F	• It did not mention impacts on cultural heritage.	• Might be mentioned with the signature of Mr. Win Naing Tun who is officer in charge for cultural heritage assessment.	• Adding an appendix with the signature.	• Append ix 5
G	• Calculation techniques due to severe stage of direct and indirect impacts and significance were not mention. (page 115-132)	• Might be mentioned calculation techniques of significance. The impacts should be mentioned with tables and impact rating matrix that will see clearly.	• As to the impacts assessment, the different factors with corresponding techniques. Some factors need to calculate such as flood and dam stability, which is added in section 6.2.10 and 6.2.11. While some assessments are upon mechanism analysis such as ecological assessment. Some are simple mathematical calculation. For example, the biomass loss equals that the area multiplies by the empirical value.	• Page 120, 121,141-149
H	• Impacts due to dam safety, ground powerhouse, reservoir bank and excavated slopes of structures were mentioned in chapter (6.2.8)Impacts on geological environment (page 130) and chapter (6.2.9)impacts of earthquake(page 133) although did not mention hydrological, geotechnical data and calculations due to flood risk, dam collapse and safety to professional interrogation. (page 130-132)	• Should be detail mentioned the calculations, hydrological and geotechnical data due to flood risk, dam collapse and safety to professional interrogation. • Proposed project area is located in high speed earthquake zone, projects are related each other according to the cascade plan and if there will emergency case, impacts will cause along the upstream and downstream side. Thus should be included dam break analysis since dam can collapse to consider environmental impacts.	• Add the specific contents by engineers from the hydraulic structure major, geology and environment	• Page 76-83, Page 137-146, Page163-166
I	• In chapter (6.2.2) impact on biological environment did not mention impact zone for every changing stages even though mentioned biodiversity impact.	• Might be mentioned impact zone for every changing stages about biodiversity impact.	• Seeing in section 6.2.2.3(1)	• Page 128,129
3	**Alternatives and Mitigation Measures**			
a	• In table (9.3.1) page 176,American dollars 1.99 million will use for environmental conservation matters, in	• Estimated fund should be recalculated concerning mitigation, monitoring measures and emergency plan for American	• The estimated investment on environmental	• Page 203-204

		• Have to mention clearly about the firmness of report and responsibilities of REM and KHIDI groups. • According to the Myanmar Engineering Council Laws in paragraph 9-g, ISO certificate of REM Company and related documents have to mention.	be seen in appendix 8, 10	
g	• Schedules for conservation of preserved forest and water distribution area due to project.	• Have to mention the schedules for conservation of preserved forest and watershed area.		• Page 202
4	**Environmental Management Plan**		•	•
a	• The whole project of environmental management plan summary is in page 165-172.General environmental monitoring plan is in page 173-175, response for contingency matters of original schedule is in page 152-156.For CSR such as health, education, road electricity and donations have total estimated cost American dollar 2,174,225 (appendix page 72)	• Have to prepare comprehensive monitoring plan for the proposed project.	• Adding more details in section 9.3	• Page 193-197
b	• General environmental management plan had already mentioned. Since each environmental management plan did not mention detail future plan, officer in charge, estimated cost and duration.	• Have to mention environmental management plan for possible impacts on each problem. • Might be detail mentioned about mitigation measures for each impact, detail monitoring plan, responsible organization and estimated fund in environmental management plan. And also should be mentioned preliminary stage, construction stage, operation stage and after closing stage of the project in detail. • All business relating to the factory enacted law 1951 have to follow working hours, health and safety of workers and child labor confirmation • Must have priority plan about occupational safety and health for workers. • Must have agreement between employer and employee, have to assign together with domestic, foreigner and local, should be carried out with appropriate department for workers from other countries. • Emergency case schedule such as explosion, fire and earthquake have to include. • Occupational health and safety are priority along the work schedule.	• Add in section 9.2.2 especially in table 9.2-1.	• Page 167, 195-197
5	**Public participation**			
a	• There had gotten suggestions from local people of two villages within project area met one time in one village during ESIA plan.(page 177- 184 and appendix page 33-45.Furthermore announcement of functions for ESIA stage is mentioned in appendix page 72.	• The project information distributed by holding stakeholder meeting, consultation meeting and activities, should be put in the report. • To public participation in the project, should be carried out widely to discuss with local people. While carrying out, gave information to all stakeholder and held consultation meeting along Ngaw Chan Kha River. All activities have to express in the report. (Daw Wutyi Phyo, Directorate of investment and company administration).	• It has been stated in the report such as page 206, which are meetings.	• Page 210, 211

b	• There had not meeting with non-government organizations, departments of state, district and townships, stakeholder meeting and public consultation meeting along the Ggwe Chan Kha River.	• Public meeting and it related data should be mentioned in ESIA report. And also would be mentioned the impacts on local people's culture heritage and wounding in their heart due to income difference.	•	• SIA
c	• 72%of villagers in Lon Pan (upper) village and 65%of villagers in Velett village did not know absolutely about project. 89% are absolutely disagree, 11% are a bit disagree and no agreeable person in Lon Pan (upper) village. In the same way 22% are absolutely disagree, 13% are a bit disagree and 39% are agreeable person in Velett village. Appendix page 38-45 • In chapter (10.5) survey results that mentioned stakeholder meeting with forty-one local people from Lon Pan and Velett villages and in chapter (10.4.1) publicity that explained to villagers of surrounding fifteen villages about project. It also announced to give suggestions about project although did not ask suggestions and opinions from local people. In chapter (10) did not include results of stakeholder meeting and comments of public consultation meeting from consultancy organizations.	• Should be carried out agreement with local people.	• It is added the cause analysis and subsequent. According to the two mentioned public participation activities, the local people understand and support the construction of Tongxinqiao HPP	• page 4 of the SIA repor
d	• Four Hydropower projects will be built on the Ngaw Chan Kha River that is within Chipwi and Hwawlaw townships. 2153 Local people from twenty surrounding villages of that hydropower project are signed and then addressed to president and office copy to Union minister, ministry of environmental conservation and forestry. Thus we can conclude that local people disagree four in one of the hydropower project Ton Shin Chaung.	• In Environmental Impact Assessment report, chapter (4.6.5.2) resettlement planning and social impact assessment report, chapter (7.1.2) relocation of settlements mentioned that (216)people from (41) households of Lon Pan (upper) and Velett villages should be moved and in appendix chapter (7.2) Restoration of Livelihood, there will have a plan about local people had been chosen themselves to Shengxiu village by arranging of government. Have to amend the sentence "Local people who will move, some have not original land ownership thus will give appropriate compensation to them and they will live with own plan." And should be adjust with local people who will get until satisfaction upon proposed project.	• It is expressed in detail in RAP report	•
	• In social survey, there did not mention which language, which method, sample size and sample method in data collections and question to local people.	• While social survey have to mention how to collect with which language by sample size and sample method.	• It is carried out with local language, which some speak Myanmar language and ethnic language. The method mainly is interviewing, meeting and questionnaires. The sample size is upon the village size, which is covering the whole villages.	• SIA report
	• Lon Pan (upper) and Velett villages are specified sensitive villages due to project while doing social survey.	• While consideration due to project affected, may be affected on downstream. Thus have to consider for that area.	• It has been stated in cumulative impacts assessment part	•

6	**Report Presentation**			
a	• Excellent in the report presentation. Fair in the data presentation. The whole report have unity thus main body of the subject matter and appendix are connecting each other.		•	
b	• It included summary in project description and current environmental situation. And also included main impacts, mitigation measures and current environmental situation.		•	•

The Republic of the Union of Myanmar

Ngaw Chang Hka, Tongxinqiao Hydropower Project

Environmental Impact Assessment Report

(FINAL)

Employer: YPIC International Energy Cooperation & Development Co., Ltd..

Prepared by: POWERCHINA Kunming Engineering Co., Ltd.

Resource & Environment Myanmar Ltd.

AUG. 2016

Approved by: Zhang Rong

Verified by: Qiang Jihong Zhao Dan

Reviewed by: Xu Tianbao Hao Hongsheng

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Bao Zhimi Zhu Yi Wu Song Shi Wenlai

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Acronyms

MOEP	Ministry Of Electric Power
MOECAF	Ministry of Environmental Conservation and Forestry
ECD	Environmental Conservation Department
IFC	International Finance Corporation
ADB	Asian Development Bank
YEIG	YPIC International Energy Cooperation & Development Co., Ltd.
REM	Resource & Environment Myanmar Ltd.
KHIDI	POWERCHINA Kunming Engineering Co., Ltd./HYDROCHINA Kunming Engineering Corporation / Kunming Hydropower Investigation and Design Institute
HPP	Hydropower project
BOT	Build- operate -transfer
CR	Critical Endanger
VU	Vulnerable
NT	Near Threatened
LC	Least Concern
CN	Endangered
LR	Lower Risk
WHO	World Health Organization

EPA	Environmental Protection Agency
D/S	Downstream
L/B	Left bank
R/B	Right bank
U/S	Upstream
EMO	Environmental Management Office
MOL	Minimum Operating Level
Ha/hm^2	hectare

Appendix

1. Approved letter on work plan

2. Working photos

3. Partial questionnaires on public consultation

4 International Treaties

5 Cultural heritage impact assessment report for Tongxinqiao

6 NCK lab results

7 Documents on the public participation

8 Commitment of the Developer to comply the environmental protection laws and regulations

9 Geology and Natural Hazards for the Tongxingqiao Hydropower Project_revised (renewed)

10 Consultants' experience and commitment

11 The modification specification/ the written revised material submitted in July, 2016 (remarks: its appendices are attached /renewed in the main report)

12 Description on Project Security of Tongxinqiao HPP under Earthquake, prepared by professional engineer and Geotechnical engineer

Attached Maps

1. Attached map 1 Geographic Map of Planning Cascades HPP And Location of Gawlan HPP
2. Attached map 2 Sketch Map of Access Roads
3. Attached map 3 General Plane Layout of the Project
4. Attached map 4 Plane Layout of the Gravity Dam
5. Attached map 5 the Upstream Elevation of the Gravity Dam
6. Attached map 6 the Cross Section of the Crest Overflowing Damblock
7. Attached map 7 the Cross Section of the Bottom Flushing Damblock
8. Attached map 8 Longitudinal profile of headrace structures

9. Attached map 9 Plane Layout of Plant area
10. Attached map10 Cross Section of Powerhouse
11. Attached map 11Gentral construction layout Model
12. Attached map 12 Affected Land Area of Tongxinqiao HPP

1 Executive Summary

1.1 Geographic Location and Overview of Project

Tongxinqiao Hydropower Project is located on the middle and lower reach of Ngaw Chang Hka within Kachin of Myanmar. The dam site is situated at approximately 320m in the lower reach of convergence point between Pailai River and Ngaw Chang Hka, about 68km away from Panwar Port. Main route for external transport of the project is as follows: Kunming ~ Anning ~ Chuxiong ~ Dali ~ Baoshan ~ Tengchong ~ Panwar ~ Tongxinqiao dam site. The total mileage of highway from Kunming to Tongxinqiao dam site is about 780km.

The water storage level of the power station is 1075m and the corresponding storage capacity is $5.14\times10^{6}m^{3}$. It enables the performance of daily adjustment and achieves installed capacity of 340MW (2×170MW), guaranteed output of 60.73MW, annual mean generating capacity of 1,695GW.h and annual utilization hours of 4,986h.

The project complex is mainly composed of concrete gravity dam, diversion system on the right bank and ground generator building, surface overflow outlets of the dam, sluicing bottom holes of the dam, and river diversion tunnel on the left bank.

1.2 Working Purpose and Process

1.2.1 Working Purpose

Based on the characteristics of Tongxinqiao HPP, the environmental status of the area and the basin, where the project is located, as well as the relevant laws and regulations of Myanmar, the main purposes of this report are as follows.

(1) investigation on the environmental status of water environment, atmospheric environment, acoustic environment, ecosystem, social environment, environmental functions, main environmental issues and its trends around the construction area.

(2) Prediction and assessment on the environmental impacts of construction, operation and resettlement, etc.by the project in the assessed area, which mainly affect the natural environment, ecosystem and social environment, etc.

(3) Working out economically and technically feasible measures to mitigate the adverse environmental impacts generated by the project construction, operation and decommissioning.

In sum, the environmental quality of the region shall meet the environmental management

requirements and the ecosystem and biodiversity shall be conserved effectively. Meanwhile, the proposed environmental management and monitoring plan and the public participation will protect the natural environment, ecosystem and social environment from the perspective of management. it will guarantee the project constructing and operating smoothly and implement the economic, social and environmental benefits on the project development.

1.2.2 Working process

The EIA study is carried out at the Feasibility study stage and based on the feasibility study achievement. It will be simply introduced the feasibility study and EIA study process here.

(1) Working process of Feasibility study

The Feasibility Study report has been reviewed and approved by the Ministry of Electricity. The main working process is as follows.

In Sept. 2009, YPIC INTERNATIONAL completed the Program for Engineering Prospecting, Design and Scientific Research in Feasibility Study Stage of Tongxinqiao Hydropower Project and the Feasibility Study Report on Tongxinqiao Hydropower Project on Ngaw Chang Hka of Myanmar (Consultation Draft). China Water Conservation and Hydropower Planning & Design Institute presided over a consultation meeting of "Program for Engineering Prospecting, Design and Scientific Research in Feasibility Study Stage of Tongxinqiao Hydropower Project" in Kunming. The consultation opinion pointed out that the Program was clear in objective, full-fledged in content and prominent in key points; the main content and work depth of survey and design on the current stage arranged in the Program was basically appropriate. The Program can be used to guide the survey and design of feasibility study work upon being modified and supplemented appropriately."

In Feb. 2010, YPIC INTERNATIONAL completed the feasibility study of Tongxinqiao Hydropower Project, determining that the normal water storage level is 1075m, selecting the project complex layout pattern of upper damsite with concrete gravity dam and diversion generating system on the right bank with a total installed capacity of 340MW. Then, the Feasibility Study Report of Tongxinqiao Hydropower Project was submitted to the government of Myanmar for examine and approval.

In June 2010, the government of Myanmar completed the review and approved the main conclusions of the Feasibility Study Report of Tongxinqiao Hydropower Project.

According to the recent agreement and correspondence between YPIC and Myanmar government in the year of 2014, the electric power consumption market of Ngaw Chang Hka cascades will change from China to Myanmar and also the access route to the project site should change from Pianma to Panwar, so the transmission line for the cascade, external transport of the project varied as well as the material price level. Meanwhile, based on the latest outcome of prospecting and design, some necessary adjustments and reasonable optimizations have been adopted to the project layout for implementation. With the above alterations took into consideration, the Feasibility Study Report of Tongxinqiao Hydropower Project need to be revised accordingly.

(2) Working process of environmental impacts assessment includes as follows:

1) POWERCHINA Kunming Engineering Corporation Limited (former name is Hydropower china Kunming engineering corporation, or Kunming hydropower investigation and design institute. hereinafter referred to as KHIDI) started hydropower planning of Ngaw Chang Hka River, and conducted preliminarily investigation of the environmental status in March 2008.

2) KHIDI conducted environmental impacts feasibility analysis of the project during the feasibility study period ranging from 2009 to 2010.

3) KHIDI carried out a scoping research, and submitted the work outline for EIA to MOEP, Myanmar during January – June 2013. the approved document is presented in Appendix 1.

4) KHIDI and Resource & Environment Myanmar Ltd. (hereinafter referred to as REM) formed a joint investigation group and entered the site for carrying out field investigation during February–May 2014. The field work photos are presented in Appendix 2.

5) REM submitted the *Environmental And Social Baseline Data Collection Report* in September 2014.

6) KHIDI compiled *EIA Report on Tongxinqiao HPP (draft), Myanmar* in October, 2014.

7) In May 2015, KHIDI discussed in details with the Environmental Conservation Department (ECD), Ministry of Environmental Conservation and Forestry, Myanmar (hereinafter referred to as MOECAF) on the update of the EIA report. The updated report is prepared based on the comments from MOECAF, as well as the existing *Guidelines* and *formats* for EIA report provided by the ECD.

8) In Dec 2015, ECD convened a meeting to review the EIA report and sent the comment to

KHIDI. This version of EIA report is modified according to the comments.

9）It is revised at April, June, July 3 times according to the comments and requirements from ECD and the Project proponent respectively, which the April version is the formal version. Then the June's version is marked the revised part and the July version is the revision written material to the amended comments one item by one.

1.3 Main Work Components

It was started in January 2013, and the draft EIA report was finished in October 2014, the main components of EIA focus on:

(1) Investigating the surround environment of the project;

(2) Analyzing the environmental reasonableness on the composition and layout of the project;

(3) Combined the current environmental status and specific project construction, identifying the environmental impacts, which include the major impacts and potential resource (project activities) of impacts to all environmental components on its construction, operation and decommissioning phases;

(4) Proposing mitigation measures for the adverse impacts and estimating the cost;

(5) Conducting investigation, analyzing and forecasting the process of natural disasters such as earthquakes and floods and proposing contingency plan for such emergencies on dam failure;

(6) Carrying out the public consultation and disclosure in the affected area.

(7) Presenting the environmental management and monitoring plan;

Based on finishing the above mentioned work, it is believed that the environmental impacts of the project construction are acceptable from the perspective of environmental protection. And the project construction is feasible.

1.4 Comparative Studies on the alternative selection

Comparative studies about the engineering schemes are mainly to carry out environmental protection in the process of feasibility study. It is involved in advance at design stage of the project, so as to ensure that the project layout will not cause irretrievable environmental impacts. Simultaneously, environmental protection factors have participated as an important

Chai maw Hka River, Lawng maw Hka River and so on.

(2) Physical environment

1) Landform

Ngaw Chang Hka River lies on the northern plateau of Myanmar, being a tributary on the left bank of Nmai Hka River, originating from the west of Gaoligong Mountain, with a total main stream length of about 144.6 km and a U-shaped river valley. The landform characteristics in this section are dominated by erosion and denudation landforms in the medium-height mountains. Main mountains and rivers are affected by structures in NNE direction. Both banks of the river have developed gullies, with relatively bad landform integrity. The river has a large gradient and narrow surface. Alluvial and diluvial terraces only develop in some river reaches.

2) Geology and seismicity

The peak acceleration of earthquake motions of bedrock with the 50-year probability of exceedance of 10% is 0.2 g in the project area. The basic seismic intensity of the site is Ⅷ -degree.

3) Hydrogeology

The project area belongs to the bed rock mountainous area, with a severely cut landform, developed folds and fractures, and relatively complex formation lithology.

4) Meteorology and Climate

The climate in the project area is the moist and rainy subtropical climate, with distinct dry and wet seasons. The average annual temperature is 15.2°C. The average annual precipitation is 1225.6 mm and the average annual evaporation is 1624.9 mm, and the average annual wind velocity is 2.1 m/s.

5) Hydrology and Sediment

The runoff of the Ngaw Chang Hka River Basin is mainly constituted by the precipitation and a small amount of melted snow. Geographically, the basin located in the north rainy area of Myanmar, where the runoff is basically consistent with the precipitation in annual variation, which is uneven. The average annual flow at the damsite is 135 m^3/s.

The floods of Ngaw Chang Hka River Basin are caused by rainstorms, which occur mainly

during June ~ August. The basin is located in the west of Gaoligong Mountain and the vapor for rainstorm mainly came from the Bengal gulf's southeastern warm moist air flow. With good vapor conditions, it is easy to cause heavy rainstorms and floods.

The average annual suspended load, sediment concentration and the bed load are 872×10^3 t, 0.484 kg/m^3 and 131×10^3 t respectively.

6) Soil and Water and Soil Loss

The soil surface (0-1m) is mainly composed of shallow silty deposit and silty clay (including the clay layer). The soil is thin and is expected to maintain its stability. The clay layer is mainly composed of low plastic silt and clay, which is the deposit from water erosion rather than the residue of primary soil. But water and soil loss is not serious because of the good vegetation coverage.

7) Surface water quality

With reference the WHO, American EPA and Chinese standards, the results of the concentration of Fe, Pb, Hg and fecal coliforms at some monitoring sections had exceeds water quality standards.

8) Atmosphere and acoustic environment

According to the monitoring data of the current environmental status and relevant standards in Thailand and Japan, the quality of air and acoustic environment in the area meet the quality standards.

(3) Ecosystem

1) Vegetation

The vegetation in the study area is mainly composed of monsoon evergreen broad-leaf forest and farmland vegetation. The tree layer is dominated by euphorbiaceae and anacardiaceae, and there are bamboos and a lot of pteridophytes as another feature. The construction area of the Tongxinqiao HPP is basically covered by secondary forest due to the destruction of human activity.

2) Flora

There are 105 plant species, including 55 trees. And the others are shrubs, herbs, climbing plants and creeping plants. There are 3 endangered species of trees, including *Schima*

wallichii, *Magnolia rostrata* Smith and *Anisoptera scaphula*. According to the red list of IUCN, the former 2 are vulnerable species, and the third is critically endangered species.

3) Fauna

Based on the field survey, there are 24 species of mammals within the assessment area of the Tongxinqiao HPP. The mammals recorded include Cercopithecidae, Cervidae etc. According to the red list of IUCN, there are 5 endangered (EN) species. They are *Manis javanica, Manis pentadactyla, Trachypithecus shortridgei, Hoolock hoolock and Cuon alpinus*. Five kinds of vulnerable species are *Ursus thibetanus, Helarctos malayanus, Catopuma temminckii, Rusa unicolor, Hystrix brachyuran* . There are 117 aves species. The predominant birds are dicruridae, corvidae, capitonidae and oriolidae. Which there are 2 near threatened (NT) species and 3 endangered speciesr. There are 1 kind of amphibians and 3 reptile species . According to the red list of IUCN, there is no endangered amphibians and reptiles in this area.

(4) Aquatic Ecology

There are 16 species of fishes, belonging to 4 families, which are collected in total in the investigation phases. The cyprinid fishes dominate with 7 species, accounting for 43.75% of the total. And Sisoridae and Clariidae followed.

There is no long distance migratory fish in the assessment area and no species recorded in the red list of IUCN.

(5) Social and economic environment

Land occupied by construction involves the Chipwi Town, Kachin State. The economic development here is dominated by agriculture. The economic level here is relatively low and the traffic conditions are poor. There are no important cultural relics and historical sites within the assessment area.

1.6 Significant Environmental Impacts

1.6.1 Impacts during Construction Period

(1) Impacts on Biological Environment

1) Impacts on Vegetation

The ecosystemal quality is good in the area related to the project. The vegetation types in the area mainly include tropical savanna, shrubs and bushes, monsoon evergreen broad-leaf

forest, bamboo forest and artificial forest. The tropical seasonal rain forest accounts for the largest proportion, flora is dominated by tropical vegetation with a good community structure. Vegetation in the project area is obviously featured by horizontal and vertical zonality.

Impacts of construction land acquisition on forests mainly include permanent land acquisition, inundation land and temporary land acquisition etc. Impacts of permanent land acquisition and inundation on vegetation and ecosystem are relatively the same because it will change the landuse type permanently and bring damages to vegetation and individual resource in plant population in such area; The result is irreversible but can be compensated at other place. Impact of temporary land acquisition is limited to a certain period mainly including the construction period, and the impact on land use, vegetation and plant resources is temporary; it will get restored gradually after project construction is over.

2) Impacts on flora

The main impact on flora during the construction period is construction land acquisition and inundation, but the impact range is relatively small and will not lead to the species extinction. However, the suitable species shall be relocated for protection.

3) Impacts on fauna

The HPP construction will bring limited impact to terrestrial vertebrates in the inundation area, which is demonstrated in the following aspects that habitats of terrestrial animals get reduced or damaged in construction phase and animals will go to another place, where is far away from the construction disturbance area. It will causes changes to animal density in a short period.

4) Impact on Aquatic Ecology

Construction activity in the river will change the water environment that fishes live in, expecially for the dam site of the river.

(2) Impact on Physical Environment

1) Impacts on the surfacewater environment

The water pollution source during project construction mainly includes wastewater and domestic sewage. Wastewater is mainly from aggregate processing system, concrete mixing, system flushing and a small amount of oily wastewater from machine repair during operation period; Domestic sewage is produced from domestic water of personnel. The wastewater

treatment systems are designed in the Report and the wastewater and sewage will not bring about much adverse impacts on the water quality.

2) Impacts on Ambient Air Environment

After some measures are taken, the impacts from the project construction on the ambient air is relatively small.

3) Impacts on Acoustic Environment

Noise during the constriction period will mainly come from such fixed source as excavation and blasting, mixing and placing, and construction machinery as well as noise from transportation. There is no concentrate settlement near the construction area, the noise will mainly influence the site workers. The impact will disappear after the construction complete,.

4) Impact on Solid Waste and Water and Soil Loss

During the construction period, the household rubbish is easy to become the bed of mosquitoes, flies and bacteria in high temperature season if it is not treated properly, which will cause reduction of environmental sanitation quality in the construction area and become a potential threat to the health of workers. If it is stacked and handled in an improper way, it may even cause pollution to river water in rainy season by washing of surface runoff.

Original landform will be disturbed due to construction activities during the HPP construction. The landuse type disturbed is mainly wild grassland, arid land, forest, dry land etc. Large quantity of waste slag may be brought by the project, where further water and soil loss is found that it mainly includes the construction area, stock pile area and spoil disposal area which accounts for over 70% of the newly-added loss volume is the focus for prevention of water and soil loss and monitoring of water and soil conservation during the project construction.

(3) Impact on Social Environment

Proportion of arable land occupied by the Project is relatively small, which will be brought to the current status of local land utilization. It can be mitigated through economic compensation.

During the HPP construction phase, the construction of the access road will improve the local transportation conditions and the investment of large amount of money during construction will be in favor of development of local economy. In addition, the demands of human

resources by the project will also provide a large number of working opportunities for the local people. And the mobilization of the construction team and the demands in goods for daily consumption will boost the development of local service industry and be positive in improving the living standard of local residents and facilitate the local economic development.

During the construction period, many workers are mobilized. If the construction area is the source of infectious disease, it may lead the workers to be susceptible population. While the living facilities in this area are simple and the medical and health condition is limited, some diseases may break out and influence their health.

1.6.2 Impacts during Operation phases

(1) Impacts on Biological Environment

1) Impacts on Vegetation

After the HPP is completed and put into operation, original utilization property of temporarily-occupied land will be restored, vegetation and natural ecosystem which are affected in the assessment area will also get restored and developed gradually. And the impacts of the HPP construction on the ecosystem will reduce and disappear gradually.

2) Impacts on flora

The protected plants are widely distributed in the primeval forest. The construction of the project and reservoir inundation will only affect a small part of the primeval forest. It means that it will bring a small impacts on the habitats of endangered species, resulting in a little impacts on the endangered plants.

3) Impacts on fauna

After the completion of project construction, ecosystem will get restored gradually and animal population will restore or increase slightly.

4) Impact on Aquatic Ecology

After project construction is completed, the adverse impacts may be brought to the aquatic environment due to dam separation, reservoir inundation, change of hydrological regime and food source of fishes and so on. However, it may be mitigated by the management plan, habitats protection and other measures so as to minimize the impact from the HPP

construction on the aquatic ecology.

(2) Impact on Physical Environment

1) Impacts on the surface water environment

As the dam building, the water level at the impounding river reach will increase and become a reservoir zone. Flow velocity in this area will reduce, duration of stay will increase and part of sediment carried by water will deposit in the area. In order to prevent river water from being cut off and maintain the basic ecological function of river. Water volume reduction at the D/S of the dam will cause a certain adverse impact to water quality of river at the D/S , capacity of water environment and habitats of fishes.

During operation period of the HPP, domestic sewage and garbage generated by the managerial personnel will be handled in a centralized way applied during the constriction period, and the impact on the water environment is relatively small.

2) Impacts on Acoustic Environment

During operation period of the HPP, operation noise of generator unit is mainly centralized at the powerhouse boundary and near the tailrace outlet, while there is no noise sensitive objective, the impact on the environment is relatively small.

(3) Impact on Social Environment

Local fiscal revenue will increase with development of the HPP, it will provide conditions like transportation, energy resources etc. And it is necessary for development of local tourism. Promotion of replacing firewood with electricity in wide mountain areas will reduce damage of forest cutting on the local ecosystem, mitigating water and soil loss and bringing the obvious environmental benefits.

1.6.3 Impacts on the decommissioning Phase

(1) Ecological impacts

It will be performed in the complex works of the HPP, without additional surface disturbance. Entry and exit of vehicles will also follow the original access road of the HPP, which will not cause direct impacts on the local vegetations, flora or fauna, only that there will be transient impacts of decommissioning on the acoustic environment and atmospheric environment, which will also be eliminated with the completion of construction.

(2) Impact on Physical Environment

1) Water environmental impacts

Water quality of decommissioning works is still good, debris, dust, wastewater of wet-process operation and rainwash in the course of construction will also enable some pollutants to enter the water body, resulting in density of SS in the water body to rise. However, it have limited impacts on the water body since the decommissioning phase is short.

2) Acoustic environmental impacts

Noises of decommissioning works will mainly come from drilling holes, blasting, bulldozers and transportation. The HPP to be dismantled is located at a remote mountainous area, the noise will cause certain disturbance to the surrounding residents, local birds and ordinary terrestrial animals. After the completion of the decommissioning works, such disturbing impacts will disappear immediately. Therefore, the acoustic environmental impacts generated by the decommissioning works will be very limited.

3) Air environmental impacts

In the course of decommissioning operation, drilling, cutting, loading and unloading spoiled materials and blasting will generate dust pollution. However, since the decommissioning quantity is small and the time is short, after duly conducting conventional protection to the construction personnel, the environmental impacts of decommissioning works on the air quality will be trivial.

4) Impacts of solid wastes

① Impacts of spoiled materials

The total quantity of structures to be dismantled will be 60×10^4 m^3, mostly being concrete debris, earth-rock excavation and waste metal residues. If they are randomly piled, they will cause impacts on the quality of local ecosystem and landscape. It is necessary to pile them at designated disposal areas.

② Impacts of domestic garbage

The dismantling works will involve short period and limited number of people, and the domestic wastes to be generated will be limited. However, random disposal will still cause impacts on the local ecosystem, and it is necessary to have them collected for concentrated

2) Water temperature

The operation of three HPPs basically will not generate low-temperature water, and also basically will not cause adverse impacts on the water temperature of Lawndin HPP in the lower reaches.

3) Water quality

The impacts of Tongxinqiao HPP on water quality of the river reach will be an cumulative process. Considering the property of waters flowing toward low levels, the cumulative impacts of Tongxinqiao HPP on water quality will still mainly be impacts on the lower reaches.

(2) Terrestrial Ecology

1) Cumulative impacts on the forest and flora

In the course of implementing the projects, the forest damaged and submerged by construction will increase, but considering that the affected area is small while there are large area of the same ecosystem in this area, the impacts is small and ti will not lead to the species extinction.

2) Cumulative impacts on terrestrial animals

With the construction of cascades, the suitable habitat of the terrestrial animal will decrease, but animals usually have strong capacity for migration or adaptation, the cascades will not make direct damage to the animals, nor change the fauna of this area. In a word, the construction of the cascades makes little impacts to the terrestrial animals.

3) Aquatic Ecology

With the construction of cascades, the cumulative impact to the aqutic ecology is mainly including water regime change of the river which lead to the decrease of the domestic fishes. And the environmental capacity of fish will be cut in the water reduced reaches.

4) Social Environment

A total installed capacity of the three cascades is 1080MW, the operation of these cascades will make a great contribution to the local economic development, improving the local investment environment, increasing the local tax income and enhancing the capacity of regional sustainable development.

After the construction of these three cascades, there will be many other impacts such as Scrolling development effect, amplification effect and learning effect.

1.7 Summary of Environmental Mitigation Measures

1.7.1 Biodiversity Conservation plan

Ecolsystem is protected through such four kinds of measures as reduction, mitigation, restoration and compensation; specific measures are as follows:

(1) Enhance cultivation for environmental protection awareness of constructors, and pay attention to publicity of laws and regulations relevant to forest protection and set "Environmental Protection Board" in the project area.

(2) Strengthen management of construction team during construction to minimize tree cutting in the project area.

(3) Carry out construction strictly in line with the project land acquisition scope, prohibit expansion of construction area and fireworks outside the construction area; forbid constructors to enter non-construction area for cutting and collecting the wild plants.

(4) Drive animals away before reservoir impounding to prevent amphibians and reptiles in hibernation from being drown.

(5) Clean the surface vegetation strictly in line with the land acquisition scope designated by the design document. Stack humus and alfisol of surface layer within the construction land scope in a centralized way for vegetation restoration and reclamation.

(6) Strengthen management for utilizing wild fire during construction to prevent forest from fire disaster.

(7) As to forest occupied permanently by the Project, implement measures like vegetation restoration at different places etc. , abiding by the national and local regulations.

(8) Appropriate Endangered plant shall be replanted at different place for vegetation restoration. Indigenous plants shall be chosen during vegetation restoration and be ensured alive before rainy season; Much attention shall be paid to vegetation protection and returning the grain plots to forestry and grassland at the upper region.

(9) Arrange the construction site reasonably and control the construction scope strictly to minimize damage caused by the project construction to habitat of animals.

(10)Reduce blasting during construction as far as possible and limit blasting time to the period from 8:00 a.m. ~ 15:00 p.m. so as to keep away from active period of animals.

(11)The principle of "Adhere to Prevention" must be insisted on and it is forbidden to dump waste soil to river and stream to ensure that impacts on habitat of amphibians is prevented or minimized.

(12)Strengthen protection training of wild animals and ecosystem for constructors, hand cubs met during construction to professional personnel of Forestry Bureau and prohibit handling at will; as for fledging and bird eggs found during construction, they must be handed to professional personnel of Forestry Bureau for proper handling.

(13)Enhance training and management for constructors, prohibit them to hunt and kill wild animals, improve their awareness of environmental protection and prevent them from buying and eating products of wild animals.

(14)Strengthen Management for Fishing During Construction

it is prohibited to catch fish not for the purpose of protection and construction management shall be carried out strictly; Excavation soil shall be transported to the spoil disposal area in time for proper storage; Collection of wastewater, sewage and household rubbish shall be conducted well; it is forbidden to dump muck, household rubbish, sewage and wastewater to river so as to prevent fish from being impacted by river water pollution.

1.7.2 Mitigation Measures for Water Environment

(1) Construction Period

The aggregate processing system shall reuse the waster water after further sedimentation treatment by secondary sedimentation method and sediment disposal shall be handled through mechanical dewatering method; Neutralized sedimentation method shall be applied to handling wastewater of concrete mixing system. Small oil separating tank shall be used for handling wastewater with oil stain. the integrated sewage treatment equipment shall be adopted for handling domestic sewage.

(2) Operation Period

① Buildings, structures and forest shall be cleared before impounding, as well as dirt, rubbish and others.

② Management of reservoir zone: drainage of sewage to the reservoir zone shall be prohibited; Vegetation around the reservoir shall be protected for water conservation. Attention shall be paid to water quality monitoring to know the status of water quality in the area promptly.

③ Domestic sewage: sewage during operation is mainly from permanent residents and shall be treated by the complete domestic sewage treatment equipment set in the Employer's camp during the construction period.

④ An accident oil contamination collection system shall be built and the accident oil contamination will be discharged into a public oil pond; waste oil treated through an oil-water separator shall be recovered and wastewater shall be used for watering of road, plant etc.

1.7.3 Measures for Protection of Air Environment and Acoustic Environment

(1) Measures for Protection of Ambient Air

Dust removal operation under wet conditions will be applied during construction, regular spraying is required for roads in the site, an air supply and ventilation system must be provided during tunnel construction. The machine overhaul location shall be set in a ventilated place as far as possible to prevent overhaul workers from injury caused by volatilization of organic matter.

(2) Measures for Protection of Acoustic Environment:

The Construction Contractor shall choose the construction process and equipment with low noise as far as possible. Noise insulation measures shall be taken for the stone processing system and concrete mixing system as far as possible, and the operation time shall be arranged reasonably. Regular overhaul and maintenance shall be conducted for construction machinery and vehicles for noise reduction.

Reasonable layout of construction site is required to separate quiet area from noise area according to characteristics of construction process; a noise source with relatively high decibel shall be set at the far end of living camps and time of relevant night construction shall be restricted.

1.7.4 Treatment Measures of Solid Waste and Prevention of Water and Soil Loss

(1) Construction Period

The household rubbish generated in the construction area shall be disposed by the sanitary landfill method. Other wastes shall be reduced as far as possible to reduce the transport expense, simplify the disposal process and reduce the disposal cost. (2) Operation Period

A rubbish collecting pool shall be set near the living area in the operation period, and dedicated personnel shall be designated to clean the household rubbish in the powerhouse and the Employer's camp everyday and to uniformly collect the rubbish to the rubbish collecting pool and then transport the rubbish to the spoil disposal area for land filling.

1.7.5 Social Environment Mitigation measures

Infectious diseases will be prevented and controlled at three routes, namely, the source of infection, route of transmission, and susceptible populations. Prevention shall be put at the first place and monitoring shall be enhanced. Meanwhile, many measures like strengthening of management for the crowd and food hygiene, establishment and improvement of medical and health institution shall be taken to enhance management of crowd health.

The adverse impacts on local economy caused by farmland acquisition by the Project will be mitigated by economic compensation.

1.7.6 Earthquake prevention measures

Considering the complex seismic geological conditions and the importance of projects , following measures such as foundation treatment measures, aseismic design, reservoir emptying measures and safety monitoring measures will be adopted for the dam and powerhouse of the project, reducing the seismic impacts maximumly. And it should be in accordanced with the relevant regulations and reference to similar engineering experience.

1.7.7 Flood impact mitigation measures

It had planned to set up the water regime acquisition and forecast system for all hydropower stations of Ngaw Chang Hka River.

In order to meet the requirements of different water level and seasonal flood discharge for Tongxinqiao project, three hole overflow orifices and two bottom water flushing outlets is

arranged on the riverbed dam section. At the same time, foundation antiseepage and drainage measures are to be adopted to make sure the stability of the dam against sliding. And taking energy dissipation and bank mitigation measures to reduce scouring of the downstream river bank.

1.8 The Public Consultation And Participation Process

In February to march 2014, REM company had introduced the project profiles and environmental impacts of *Tongxinqiao HPP* in every involved villages. It also convened symposium with Chipwi government for advice , and the symposium was reported by local newspapers.

In total, 2 villages with about 41 persons as the survey object participated in the survey. Only 16% of the interviewees know that the HPP construction is to be developed in the basin, mainly getting informations from the local governments, public media, neighbors and development personnel entering the local place for the preliminary works. In addition, 70% of the interviewees supported or are very glad to support the HPP. These interviewees suppose that the HPP basically will not bring about any adverse environmental impacts while other interviewees suppose that there may be some adverse environmental impacts. The interviewees from Ve Lat Village supposed that the agriculture will be affected severely and more than 91% of the interviewees suppose that development of the HPP will bring about slight impact on the society and population health. The villagers' main comments are as follows: after the HPP is safely completed, the HPP can properly serve the villages around and provide them with good services in terms of electricity, medical treatment and traffic; meanwhile, they worry about that the HPP construction will bring about adverse impacts on the local agriculture, mainly referring to reservoir inundation and paddy fields and lands occupied by construction, which may affect the agricultural production; In addition, they also worry about that dust generated by construction transportation will affect their respiratory systems;Furthermore, the large quantity of constructors will make them feel unsafe.

1.9 Summary of Environmental management

In strictly compliance with the premise of the Myanmar government related laws and regulations, the owner should improve their own capacity building, carrying out works under the supervision and guidance of the Myanmar government. The owner also establish its own enviromental management offices which will manage and carry out all the enviromental

mitigation measures that proposed by EIA.

During the construction stage, the Owner will establish Environmental Management Office (hereinafter referred to as O's EMO) , and based on environmental supervision and the Contractor's Environmental Management Office (hereinafter referred to as C's EMO) to carry out the environmental mitigation measures.

During operating stage, the owner are responsible to make plan of annual environmental protection work, implementing of the environmental protection funds and arranging the operating stage environment monitoring and implementing environmental management.

Environmental monitoring plan mainly includes the water environment monitoring, ambient air monitoring, acoustic environment monitoring, population health monitoring, terrestrial and aquatic organism monitoring, etc.

1.10 Economic Cost/Benefits Analysis of the Enviromental Impacts

In order to mitigate the environmental pollution issue caused by the project construction and operation period, multiple mitigation measures, such as measures for protection of water environment and biodiversity in this project were proposed. All the environmental mitigation measures during the construction period is planned to spend $\$1.9973\times10^6$. After taking the environmental mitigation measures, the quality of natural environment and ecosystem will be effectively protected. In order to guarantee the environmental quality of the area from being degraded, protect the natural environment, and safeguard sustainable development of the area, the costs of these mitigation measures are reasonable.

1.11 Conclusions and Recommendations on the EIA Report

Tongxinqiao HPP is a project to develop and utilize hydroelectric resources encouraged by the government of Myanmar. Its construction will play an important role in promoting regional economic development, and also generate certain adverse impacts, which are mainly manifested as dam construction that fragmentation the habitats of fishes, reservoir submerging and construction land occupation damaging vegetations, animal and plant resources, exhaust gas, waster water, solid waste (hereinafter referred as Three Wastes) and noise pollution during the construction period. Water loss and soil loss caused by construction disturbing the ground surface, etc.

Regarding the adverse impacts of construction stage and operating stage , we designed such

environmental mitigation measures as vegetation compensation and restoration measures that fish mitigation measures, water pollution prevention measures, ambient air prevention measures, acoustic prevention measures and solid waste prevention measures. It will take above measures to minimize various adverse environmental impacts of the project on the ecosystem. Construction of Tongxinqiao HPP will not involve any environmentally sensitive area defined by the national or local government of Myanmar. There is not any environmentally sensitive element restricting the project construction, and so long as we truly carry out various environmental mitigation measures and suggestions proposed in this report, the adverse impacts generated by project construction are acceptable. Therefore, analyzing from the perspective of environmental protection, construction of Tongxinqiao HPP is feasible.

2 Introduction

2.1 Purpose of Assessment

The main purposes of this report are as follows. It is in accordance with the features of Tongxinqiao HPP, the environmental characteristics of the area and Ngaw Chang Hka Basin where the project is located and the relevant requirements of Myanmar government.

(1) Construction of Tongxinqiao HPP should meet the requirements in the relevant domestic policies, laws and regulations on environmental protection in Myanmar.

(2) investigating status of water environment, atmospheric environment, acoustic environment and ecosystem the project area and the reach of Ngaw Chang Hka River where the project is located, the environmental functions, main environmental issues.

(3) It is to forecast and assess the impacts of such engineering activities as project construction, operation and resettlement on the environment of the assessed area, analyze and assess various environmental impacts of the project construction on Ngaw Chang Hka Basin (including favorable and adverse impacts).

(4) It is to work out economically and technically feasible environmental mitigation measures against the unfavorable environmental impacts brought by the project construction, operation and resettlement, so that the environmental quality of the region and the ecosystem may be effectively conserved, so as to guarantee smooth construction and normal operation of the project, adequately tap the economic, social and environmental benefits of the project, and promote the benign development of ecosystem of the project area and Ngaw Chang Hka Basin.

(5) It is to propose environmental monitoring scheme for project construction and operation period, grasp the status of environmental impacts of the project, timely conduct feedbacks, correct and improve the environmental mitigation measures.

(6) It is to work out schemes for environmental supervision and management, clarify the tasks and duties of all the parties, and provide institutional guarantee for implementation of environmental mitigation measures.

It is to analyze and forecast the overall trend of changes of environmental quality of the area involved in the project after implementing environmental mitigation measures, demonstrate the feasibility of constructing Tongxinqiao HPP from the aspects of environmental impacts, so

as to provide scientific bases for demonstrating the project scheme, environmental management and decision of the project.

2.2 Brief Introduction to the Project Developer

The Owner of Tongxinqiao HPP is the JV company formed by YPIC International Energy Cooperation & Development Co., Ltd. (YPIC), IGE Co., Ltd. and MOEP. To be specific, YPIC is the investor for construction of the HPP. YPIC is an enterprise subordinate to Yunnan Provincial Energy Investment Group Co., Ltd. (hereinafter referred to as YEIG), which was registered on July 9, 2007. YPIC mainly carry out businesses in countries outside China, involving in such industries as energy, building materials, investments, project construction contracts and mining development, etc.

As the international operation platform of YEIG, YPIC plans to finish building the project operation platform with the four countries of Laos, Myanmar, Indonesia and Nepal as the core, and the financial operation platform with Hong Kong Company and Singapore Company as the core by 2020, so as to control a total installed capacity of 3 million kW, and form the industrial layout with hydropower projects and cement plants as the core, realizing 4 billion RMB of total assets, 1 billion RMB of total revenues, and 100 million RMB of profits.

2.3 Division of Labor between KHIDI and REM

KHIDI and REM are jointly responsible for EIA of Tongxinqiao HPP. KHIDI is fully responsible for the project, while REM is responsible for ecological investigation, environmental baseline monitoring on site, and preparing the investigation report. KHIDI is responsible for summarizing, analyzing and collating the information for the EIA report, forecasted and analysed about the environmental impacts in light of the information furnished by REM, and is responsible for preparing the final report. Project team members are detailed in Table 2.3-1, Table 2.3-2.

Table 2.3-1 Members of KHIDI EIA working team

No.	Name	Assessment scope	Position
1	Mr. Shao Rong	Environmental protection	Principal Consultant
2	Mr.Xie Qiangfu	hydrology and water resources	Principal Consultant
3	Mr.Zhang Rong	Ecology	Principal Consultant
4	Dr. ZhaoDan	Hydraulics	Principal Consultant
5	Mr.Li Ying	Environmental science	Principal Consultant
6	Ms. Qiang Jihong	Environmental science	Principal Consultant
7	Dr. Hao Hongsheng	environmental hydraulics	Senior consultant
8	Mr.Hou Yongping	Ecology	Senior consultant

9	Mr.Xu Tianbao	environmental sciences	Senior consultant
10	Mr. Gao Qihui	Ecology	Senior consultant/project director
11	Ms. Baozhimi	environmental engineering	Consultant
12	Ms. Li Qiujie	biology	Consultant
13	Ms. Liu Yuan	Botany	Consultant
14	Mr.Qiao Lei	environmental engineering	Consultant
15	Mr.Wangqingliao	Surface water environment	Consultant
16	Mr.Chen Pingping	Soil and water conservation	Consultant
17	Mr.Deng Can	environmental engineering	Consultant
18	Ms.Gao fei	Soil and water conservation	Consultant
19	Dr. Wang Weiying	Aquatic ecology	Consultant
20	Ms.Zhu Yi	environmental engineering	Consultant
21	Ms.Shi wenlai	environmental engineering	Consultant
22	Dr.Wu Chen	Ecology	Consultant
23	Mr.Wu song	environmental hydraulics	Consultant
24	Liu Shaochuan	Hydropower structure	consultant
25	Chengwei	Geology	consultant
26	Xu wen	Construction organization design	consultant
27	Meng fanhao	Hydropower planning and hydrology	consultant

Table 2.3-2 Members of the Environmental Survey Team

Sr.	Name	Assessment Scope	Position
1	Dr. Win Maung	Ecology	Principal Consultant
2	Dr. Aung Pyae Khant	Ecology	Senior Consultant
3	Mr. Saw Thura Min	Ecology	Senior Consultant
4	Mr. Tay Zar Aung	Ecology	Senior Consultant
5	Mr. Aung Aung	Ecology	Consultant
6	Mr. Thet Naing Aung	Ecology	Consultant
7	Mr. Htet Naing Tun	Ecology	Consultant
8	Ms. Khin Ohnmar Htwe	Socialeconomics	Senior Consultant
9	Dr. Aung Ye Kyaw	Health Assessment	Consultant
10	Dr. Nyein Thu Aung	Health Assessment	Consultant
11	Dr. Ye Naing	Health Assessment	Consultant
12	Mr. Saw Tar Yay Htoo	Socialeconomics	Consultant
13	Mr. Chit Loon	Socialeconomics	Consultant
14	Ms. Zin Mar Than	Socialeconomics	Consultant
15	Mr. Aung Zaw Min	Socialeconomics	Consultant
16	Mr. Win Naing Tun	Cultural Heritage	Principal Consultant
17	Mr. Zaw Naing Oo	Physical Environment	Principal Consultant
18	Mr. Thura Aung	Physical Environment	Senior Consultant
19	Dr. Lin Thu Aung	Physical Environment	Consultant
20	Dr. Thiha Soee	Geology	Principal Consultant
21	Mr. Nay Min Aung	Physical Environment	Consultant
22	Mr. Myint Tun Aung	Physical Environment	Consultant
23	Mr. Nyan Linn Maung	Aquatic Ecology	Consultant
24	Mr. Win Naing Tun	Cultural Heritage	Principal Consultant

25	Mr. Soe Thura Tun	Management	Managing Director
26	Mr. Ngwe Moe	Management System	Principal Consultant
27	Mr. Kyaw Zin Win	GIS data	Principal Consultant
28	Dr. Myo Oo	Health Assessment	Advisor
29	Mr. Maung Maung Aye	Environmental Quality	Advisor
30	Mr. Nyo Maung	Ecology	Advisor

2.4 Brief Introduction to EIA Work

In March 2008, KHIDI organized engineers of different disciplines and relevant personnel of YPIC and Kunming Chuangcheng Industry and Trade Co., Ltd. to jointly make the first site investigation and visit to Ngaw Chang Hka Basin and completed *the Preliminary Investigation Report on Cascaded HPPs on Midstream and D/S Reach of Ngaw Chang Hka River* in accordance with site comprehensive investigation conditions and preliminary indoor analysis.

In October 2008, KHIDI organized engineers of different disciplines and relevant personnel of YPIC to jointly make the second site investigation and visit to Ngaw Chang Hka Basin, completed Preliminary Ass*essment Report on Hydro Resources and Development Conditions of Ngaw Chang Hka River*, and preliminarily planned the six-cascade development schemes (namely, Gawlan, Wxhongze, Hkankwan, Tongxinqiao and Lawndin and Khu yaung) in accordance with site comprehensive investigation conditions and preliminary indoor analysis.

In July 2009, KHIDI worked out *Hydropower Report on Planning Essential Points of Ngaw Chang Hka Rive*r and five-cascade development scheme are applied to the planned river reach (namely, Gawlan, Wxhongze, Hkankwan, Tongxinqiao and Lawndin) as recommended in the Report, and the total installed capacity of the planned cascaded HPPs is 1,200MW. In July of the same year, the government of Union of Myanmar organized relevant agencies to assess and examine *Hydropower Report on Planning Essential Points of Ngaw Chang Hka River*. In September, YPIC invited China Renewable Energy Engineering Institute (hereinafter referred to as CREEI) to consult *Hydropower Report on Planning Essential Points of Ngaw Chang Hka River*. The assessment and consulting comments of both Chinese and Myanmese parties are of unanimous opinion that five-cascade development scheme is applied to the planned reach of Ngaw Chang Hka River.

In March 2010, KHIDI finished preparing *Feasibility Study Report on Tongxinqiao HPP, Myanmar* (Chinese and English versions).

In October, in order to duly carry out EIA for construction of the HPP, KHIDI preliminarily determined the basic ideas for carrying out EIA of Tongxinqiao HPP, and finished preparing *Work Outline for EIA of Tongxinqiao HPP*.

In December 2012, YPIC, REM and KHIDI discussed about EIA of four hydropower projects on Ngaw Chang Hka River, including Tongxinqiao HPP, eventually reached an agreement, and determined that REM will mostly be responsible for EIA field investigation of Tongxinqiao HPP.

In June 2013, MOEP approved the *Work Outline for EIA of Tongxinqiao HPP* submitted by KHIDI, agreed to KHIDI and REM jointly carried out the EIA of Tongxinqiao HPP, and specified the main TOR, report format and other important components.

In February – March 2014, REM sent scientists of different disciplines to conduct twice special investigations about EIA of Tongxinqiao HPP, including terrestrial ecosystem, aquatic ecosystem, water environment, acoustic environment, atmospheric environment and social environment, etc.

On September 25, 2014, REM submitted the initial draft of investigation report (English version) to KHIDI. Thereafter, KHIDI and REM kept communication on the components of the report, and kept revising, supplementing and improving the report.

At the end of June 2015, KHIDI finished *EIA Report on Tongxinqiao HPP*, based on the field investigation report by REM, and analysis and demonstration on the project and its environmental impacts.

3 Policy, Legal and Institutional Framework

3.1 Myanmar Legislation and Institutions concerning environment

Myanmar has already developed legislation and regulations relating to environmental protection since before its independence. The Forest Act and the Myanmar Wildlife Protection Act, for example, had been enacted respectively in 1902 and 1936 for the sustainability of forest products. Amended versions of such earlier acts and newly promulgated ones are herein briefly outlined to give a perspective on the existing legal and administrative framework concerning the environmental affairs in Myanmar.

3.1.1 Responsible Agencies for environmental management

In Myanmar, ministries are involved sect orally in legislation and administration of environment-related laws and acts depending on the technical nature of respective ministry and relevant environmental aspects. The principal ministries implementing and administering such enacted laws and regulations on behalf of the government are, namely, Ministry of Forestry, Ministry of Mines, Ministry of Culture, Ministry of Agriculture and Irrigation, Ministry of Health, Ministry of Hotel and Tourism, and Ministry of Livestock and Fisheries. They issue orders, directives and notifications as necessary.

The National Commission for Environmental Affairs (NCEA), formed under the Ministry of Foreign Affairs in 1990, playing a role as a central/focal coordinating body for environmental matters, particularly adopting national policies on environment until 2011. At that time, the Minister of Foreign Affairs was the only one who had been involved in international environmental conferences, and tried to organize and set up environmental governance in Myanmar.

After the elected government of 2010, the Ministry of Forestry has been reformed into Ministry of Environmental Conservation and Forestry (MOECAF) and an Environmental Conservation Law (2012) has been approved by Myanmar Government. Environmental Conservation Department (ECD) has become national level coordinating body to deal with environmental matters such EIA, Environmental permissions.

3.1.2 Environmental legislation and policies

In the state constitution, "environment" means "natural environment". It declares that "The state shall protect the natural environment".

The National Commission on Environmental Affairs (NCEA) has adopted a National Environmental Policy in 1994 to ensure the incorporation of environmental concerns in planning for economic development. The National Environmental Policy (NEP) emphasizes "the responsibility of the State and every citizen to preserve its natural resources in the interest of present and future generations".

The commission also formulated a blue print, the Myanmar Agenda 21, in 1997 in response to the call of the Earth Summit to develop national strategies to implement the Global Agenda 21. This document may serve as a framework for integrating environmental considerations in future national development plans as well as sectoral and regional development plans in Myanmar.

Besides the above-stated documents, there are several laws and regulations relating to the environmental matters administered by various relevant ministries in Myanmar. These are listed inTable 3.1-1. Some current major legislation is also tabulated with their main purposes in Table 3.1-2.

Table 3.1-1 The existing Myanmar laws relating to environment

A. Administrative Sector
1. The Territorial Sea and Maritime Zones Law, 1977
2. The Emergency Provisions Act, 1950
3. The Essential Supplies and Services Act, 1947
4. The Police Act, 1945
5. The Poisons Act, 1919
6. The Explosive Substances Act, 1908
7. The Towns Act, 1907
8. The Village Act, 1907
9. The Yangon Police Act, 1899
10. The Explosives Act, 1887
11. The Penal Code, 1861 of Offences Affecting the Public Health, Safety, Convenience, Decency and Morals.
B. Agriculture and Irrigation Sector
12. The Plant Pest Quarantine Law, 1993
13. The Pesticide Law, 1990
14. The Embankment Act, 1909
C. Culture Sector
15. The Protection and Preservation of Cultural Heritage Region Law, 1998
D. City Development Sector
16. The Development Committees Law, 1993
17. The Mandalay City Development Law, 1992

18. The City of Yangon Development Law, 1990 (Amended in 1995 and again in 1996)
19. The Underground Water Act, 1930
20. The Water Power Act, 1927
21. The City of Yangon Municipal Act, 1922 (The Law Amending the City of Yangon Municipal Act, 1991)
22. The Yangon Water-works Act, 1885

E. Finance & Revenue Sector

23. The Myanmar Insurance Law, 1993

F. Forestry Sector

24. The Protection of Wild Life and Wild Plants and Conservation of Natural Areas Law, 1994
25. The Forest Law, 1992

G. Health Sector

26. The National Food Law, 1997
27. The Traditional Drug Law, 1996
28. The Prevention and Control of Communicable Diseases Law, 1995
29. The National Drug Law, 1992
30. The Union of Myanmar Public Health Law, 1972

H. Hotels and Tourism Sector

31. The Myanmar Hotel and Tourism Law, 1993

I. Industrial Sector

32. The Private Industrial Enterprise Law, 1990
33. The Factories Act, 1951
34. The Oilfield (Workers and Welfare) Act, 1951
35. The Petroleum Act, 1934
36. The Oilfields Act, 1918

J. Livestock and Fisheries Sector

37. The Animal Health and Development Law, 1993
38. The Freshwater Fisheries Law, 1992
39. The Myanmar Marine Fisheries Law, 1990 (The Law Amending the Myanmar Marine Fisheries Law, 1993)
40. The Law Relating to Aquaculture, 1989
41. The Law Relating to the Fishing Rights of Foreign Fishing Vessels, 1989 (The Law Amending the Law Relating to the Fishing Rights of Foreign Fishing Vessels, 1993)

K. Mining Sector

42. The Myanmar Gemstone Law, 1995
43. The Myanmar Pearl Law, 1995
44. The Myanmar Mines Law, 1994
45. The Salt Enterprise Law, 1992
46. The Land Acquisition (Mines) Act. 1885

L. Science and Technology Sector

47. The Science and Technology Development Law, 1994

M. Transportation Sector

48. The Highways Law, 2000
49. The Motor Vehicles Law, 1964 (The Law Amending the Motor Vehicles Law of 1964 enacted in 1989)

50. The Myanmar Aircraft Act, 1934
51. The Inland Steam Vessels Act, 1917
52. The Ports Act, 1908
53. The Defile Traffic Act, 1907
54. The Yangon Port Act, 1905
55. The Canal Act, 1905
56. The Obstruction in Fairways Act, 1881

Table 3.1-2 Legal Framework related to HD project EIA Study

Title	Brief Description
National Environmental Policy (1994)	To establish sound environmental policies in utilization of water, land, forest, mineral resources, and other natural resources in order to conserve the environment and to preserve it degradation. It is the responsibility of every citizen to preserve its natural resources in the interests of present and future generations. Environmental protection should always be the primary objective in seeking development.
Myanmar Agenda (1997)	Agenda encourages on mobilization and focus national efforts to achieve sustainable development and facilitation the incorporation of environmental considerations in the development process of the economic and social sectors
The 2008 Constitution	Governments' commitment to protect and preserve natural environment
Environmental Conservation Law (2012)	provision of basic guidance to integrate environmental conservation in sustainable development, ministry's responsibility to develop relevant guideline and regulation, setting up monitoring system, waste management, conservation of natural resource and cultural heritage.
Environmental Conservation Rule (2014)	The principle of this rule is to support the execution conducted by ministry as required by environmental conservation law.
EIA Procedures (2014)	Description of categories of project to conduct EIA and IEE requirement, content of EIA, submission and approval principle, environmental certificates, responsibilities of ministry and project proponent
The Forest law (1992)	To implement forest policy and environmental conservation policy, to promote the sector of public cooperation in implementing these policies, to develop the economy of the State, to prevent destruction of forest and biodiversity, to carry out simultaneously conservation of natural forests and establishment of forest plantations and to contribute to the fuel requirements of the country.

The protection of wildlife, wild plant and Conservation of Natural Area Law (1994)	To protect wildlife, wild plants and conserve natural areas, to contribute towards works of natural scientific research, and to establish zoological gardens and botanical gardens. Law describe (a) to implement the policy of protecting wild life and wild plants of the Government,(b)To implement the policy of conserving the natural areas of the Government,(c) To carry out in accordance with International Conventions adopted by the State in respect of the preservation of wild life and wild plants, living and non-living organisms and migratory birds (d) To protect wild life and wild plants liable to the danger of extinction and the habitats thereof(e)To contribute towards works of natural scientific research.
The protection of preservation of Cultural Heritage Region Law (1994)	Obligation not to carry out any of the following in the cultural heritage region (a) Destroying an ancient monument; (b) Willfully altering the original ancient form and structure or original ancient workmanship of an ancient of an monument; (c) Excavating to search for antiques; (d) Exploring for petroleum, natural gas, precious stones or minerals.
Land Acquisition Act (1894)	Enacted in 1894 during British Colony time, this act highlights the process and duty of government to acquire the land for sake of country with notification to owners, compensation for land and damage to land
Farmland Law and Rule 2012	The law provides the rights of farmers to a certain extent than the similar laws in the last 50 years. There is significant improvement in this law with regard to the right of farmers such as right to sell the land and ownership. Any form of acquiring farm land to convert to investment project for sake of country shall be strictly followed in accordance with these law and rule
Foreign Investment Law (2012)	Provision of comprehensive legal regime to foreign investors.
The Electricity Law (2015)	Generally, set forth the principle of permission required by relevant authorities to installation, generation, transmission, distribution and inspection tasks. Permission might be withdrawn under the circumstance that licensed organization infringe the requirements stipulated in agreement. Projects are divided into three categories as small, medium and large.
The Conservation of Water Resources and River Law	This law aims at protection of water resources and river, avoidance of environmental impact, enhancement in navigation and safe water way

(2006)	and contribution to State economy
The Conservation of Cultural Heritage Objects Law (2015)	Generally, set for steps to adhere in the event of discovering objects which are judged as culturally valuable. Types of cultural heritage objects and reporting process are also listed.
Protection and prevention of ancient buildings (2015)	This law aims at conservation of historically valuable buildings deemed under the law.
The Prevention of Hazard from Chemical and Related Substances Law (2013)	This law was enacted to protect from being damaged the natural environment and any harm to living bengs through systematic production storage, transportation, usage and disposal of dangerous substances.
Upper Burma Land and Revenue Regulation (1889)	This regulation aim to collect land revenue from all cultivable lands.
Town and village Land Act (1876)	The Act aim to help assist the government bureaucracy and administrative mechanism, to demarcate the boundaries, to undertake settlement operations to assess revenue, etc, Lower and Upper Burma Act were enacted.
Social Security Law (2011)	The Social Security Law, enacted in 1012, was amended the Social Security Act in 1954. It stipulates the formation and implementation of social security system.
Workmen's Compensation Act (1922)	It stipulates that employer is required to make payments to employees who become injured or who die in any accidents arising during and in consequence of their employment. Such compensation also must be made for disease which arise as a direct consequence of employment, such as carpal tunnel syndrome.
The Minimum Wage Law (2013)	The law was replaced the 1949 Minimum Wage Act. The Law provides a framework for minimum wage determination, the presidential office establishing a tripartite minimum wage committee shall decide minimum wage with industrial variation base on a survey on living costs of workers possibly every two years. This also stipulates equal payment.
Employment and Skill Development Law (2013)	The law aims to facilitate employment which is appropriate to the age and ability of the job seeker and to help workers obtain employment and to provide stability of employment and skills development for employees ant also too help employers obtain appropriate employees.
The Leave and Holiday Act (1951)	This act has been used as the basic framework for leaves and holidays for workers with minor amendment in 2006 and 2014. This defines the public holidays that every employee shall be granted with full payment. It also defines the rules of leaves for workers including medical leave, earned leave and maternity leave.

The Labour Organization Law (2011)	The Labour Organization Law replaced the Trade Union Act enacted in 1927 for protecting the rights of the workers, having good relations among the workers or between the employer and the worker, and for forming and carrying out the labour organizations systematically and independently. Under the law, the labour organization has the right to carry out freely in drawing up their constitution and rules. It has the right to negotiate and settle with the employer if the workers are unable to obtain the right of the workers contained in the labor laws. On the other hand, the employer shall recognize the labour organizations and assist as much as possible if the labour organizations request for help for the interest of his workers.
The Labour Dispute Settlement Law (2012)	This law was enacted for safeguarding the right of workers or having good relationship between employer and workers and making peaceful workplace or obtaining the rights fairly, rightfully and quickly by settling the dispute of employer and worker justly. It stipulates that employer in which more than 30 workers are employed shall form the workplace coordinating committee consisting of the representatives of workers and the representatives of employer.
The Protection and Preservation of Antique Objects Law (2015)	It aims to implement the policy of protection and preservation of the perpetuation of antique objects and to protect and preserve antique objects so as not to deteriorate due to natural disaster or man-made destruction.
Motor Vehicles Law (2015)	It aims to drive safely motor vehicles in public area through registration according to official rules and regulations, to provide driving license, to protect the road users from the road risks and vehicles perils, to avoid traffic congestion and to use high technology transportation systems.
Export and Import Law (2015)	It aims to implement the economic principles of the State successfully, to lay down the policies to export and import that support the development of the State, and that are to be in conformity with the international trade standards.
Myanmar Engineer Council Law (2013)	It aims to develop the dignity, ethical principles and ability of Myanmar citizen engineers and technician who are working in the engineering services sector and to guide, control, maintain and take necessary action with regard to specified standards and norms relating to specified subjects, systematic methods and principles in engineering subjects and in technological research and services.

3.2 International treaties and agreements ratified and/or signed by the Government

Myanmar has also made commitments to the thirty one international agreements on environmental issues. These are presented in Appendix (1).

3.3 Institutional and Management Arrangement

The Ministry of Environmental Conservation and Forestry (MOECAF) addresses environmental issues through engagement, coordination and cooperation both at sectoral and national levels. Myanmar Investment Commission (MIC) has requested all the development projects to conduct proper EIA from middle half of 2012, after issuing MIC Notification (1/2012) on February 2012.

3.3.1 National Coordination Framework/Mechanism

The Environmental Conservation Committee (ECC) of the Lower House (Pyithu Hluttaw, similar to Congress) is the policy maker and Ministry of Environmental Conservation and Forestry (MOECAF) act as National Coordinating Body. In fact, MOECAF was established to advise the Government on environmental policies, to act as a focal point and as a coordinating body for environmental affairs; and to promote environmentally sound and sustainable development in Myanmar.

The Environmental Conservation Rules are being notified by the Ministry of Environmental Conservation and Forestry on 5 June 2014 in exercise of the powers conferred by Section 42 Subsection (a) of the Environmental Conservation Law and with the approval of the Union Government.

3.3.2 Ministry of Environmental Conservation and Forestry (MOECAF)

Since Myanmar has initiated its move towards democracy the Ministry of Forestry was reformed as Ministry of Environmental Conservation and Forestry (MOECAF) in 2011 as a national level agency to coordinate and handle environmental related issues and matters including the implementation of international environmental agreements signed by government, law enforcements and information dissemination. Since then NCEA was cancelled and MOECAF has been acting as focal coordinating body for country's overall environmental management and environmental matters.

There are six departments under the MOECAF, namely,

(a) Planning and Statistics Department

(b) Forest Department

(c) Dry zone Greening Department

(d) Environmental Conservation Department (ECD)

(e) Survey Department

(f) Myanma Timber Enterprise

The Environmental Conservation Department (ECD) was established in October 11, 2012 to take responsibility for the effective implementation of environmental conservation and management in Myanmar. The objectives of forming ECD are shown below.

(a) To implement the national environment policy

(b) To develop short, medium and long term strategy, policy and planning for the integration of environmental consideration into the sustainable development process

(c) To manage natural resources conservation and sustainable utilization

(d) To manage the pollution control on water, air and land for environmental sustainability

(e) To cooperate with government organization, civil societies, private and international organizations for the environmental affairs.

The ECD has been hosting various environmental and sustainable related workshops and meetings in an effort to develop Myanmar's human resource, knowledge and technical expertise in environmental sector, transferring and encouraging knowledge sharing from international counterparts and experts.

MOECAF has supported preparation of environmental regulations such as EIA rules, environmental quality standards through collaboration with international financial institutions and United Nations organizations. MOECAF has planned to organize sub divisions under ECD and extend its manpower in near future with the aim of effectively implementing and managing environmental regulations and resources nationally. The newly organized environmental divisions include the following:

(a) Administration

(b) Planning & Internal relation

(c) Pollution control

(d) Natural resource and EIA

(e) State and Region departments.

As the job allocation and staffing within the department are being developed detailed functions and responsibilities given to individual departments remain unknown at the time of the reporting.

3.3.3 Sectoral Framework and Mechanisms

Different ministries involved in dealing with environmental issues also have their own policies, capacities, processes, legislations, and budgets. The Ministry of Environmental Conservation and Forestry has its own budget for the reforestation component of the Land Degradation Programme. There is however, close cooperation between different ministries for sharing information regarding budgets as on other matters. Capacity and institution building in the short and medium term is being carried out by each ministry separately. Governmental organizations and their prime environmental issues are summarized inTable 3.3-1.

Table 3.3-1 Governmental organizations and relevant environmental issues

Environmental Issues / **Governmental Organizations**	Air Pollution	Water Pollution	Banned Pesticides	Environment in Factory	Toxic chemicals	Solid Waste	Energy	Water Supply	Waste Water Treat	Forest and Desert	Biodiversity	Natural Resources	Natural Disaster	Environmental Education
Ministry of Environmental Conservation and Forestry	○	○	○	○	○	○	○	○	○	○	○	○	na	○
Ministry of Agriculture and Irrigation	-	○	○	-	○	○	-	○	-	○	-	○	-	○
Ministry of Livestock and Fisheries	-	-	-	-	-	-	-	-	-	-	-	○	-	-
Ministry of Industry	-	○	na	-	○	○	-	na	○	-	-	-	-	-
Ministry of Health	na	○	na	na	○	○	-	○	-	-	-	-	-	○
Ministry of Energy	-	-	-	-	-	-	○	-	-	-	-	na	-	-
Ministry of Electric Power	-	-	-	-	-	-	-	na	-	-	-	na	-	-
Ministry of Transport	-	-	-	-	-	-	-	○	-	-	-	na	-	-
Ministry of Home Affairs	-	na	-	-	-	-	-	-	-	-	-	-	○	-
Ministry of Labour	○	○	-	○	-	-	-	-	○	-	-	-	-	-
Ministry of Mine	○	na	-	-	na	na	-	-	-	-	-	○	-	-
Ministry of Science and Technology	na	na	na	-	○	○	○	-	-	-	-	-	-	○
Ministry of Education	-	-	-	-	-	-	-	-	-	-	-	-	-	○
Ministry of National Planning	-	○	-	-	-	-	-	-	-	-	-	-	-	-

and Economic Development														
Ministry of Progress of Border Areas, National Races and Development Affairs	-	-	-	-	-	-	-	○	-	○	-	-	na	-
Myanmar Investment Commission	-	○	-	-	-	-	-	-	-	-	-	○	-	-
National commission for Water and Sanitation	-	na	-	-	-	-	-	○	-	-	-	-	-	-
Industrial Development Central Committee	○	○	-	-	-	-	-	-	-	-	-	-	-	-
Disaster Prevention Central Committee	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yangon City Development Committee	○	○	-	-	○	○	-	-	○	-	-	-	-	-
Mandalay City Development Committee	○	○	-	-	○	○	-	-	○	-	-	-	-	-

Note: 1) : ○ → Relevant Organization - → No responsible na → Lack of information

(Source: Data compilation by Myanmar Environment Institute 2012)

3.3.4 Laws and regulations - local ordinances to be applied for construction of development projects

There are no adequate laws and rules related to construction activities in Myanmar especially health, safety, and environment (HSE). As stated earlier in this report the project proponent and/or the operator are responsible for following existing international guidelines such as ADB or Work Bank (IFC) etc. "The ministry (MOECAF) recommends the environmental consultants to follow and adhere to the international environmental standards including the Asia Development Bank (ADB) and International Finance Corporation (IFC) (Personal Communication between MOECAF and Resource & Environment Myanmar, in Nov, 2012).

There are no specific laws or rules concerning construction activities, however some un approved regulations exist for Yangon City, i. e. to have agreement of nearby community (10 household continuous to the work site) for approving construction noise, vibration, and odors. Some rules might be included (impartially) in the proposed environmental rules, but this has not been put into law yet.

(1) Environmental Conservation Law

Because of the recent establishment of Law of Environmental Conservation signed by the President on 30th March 2012, detail duty and coordination framework and mechanism has not been thoroughly settled yet. The ministry (MOECAF) recommends the environmental consultants to follow and adhere to the world known environmental standards e. g. the Asia Development Bank (ADB) and International Finance Corporation (IFC) (Personal

Communication between MOECAF and Resource & Environment Myanmar in Nov, 2012).

A brief outlines of the law is described here for a reference. The law consists of 14 chapters and 42 articles. Some important Chapters and Articles are briefly discussed in the following sessions.

Chapter II: Objectives

The objectives of the law as described in Chapter II are listed below.

(a) To implement the Myanmar National Environmental Policy;

(b) To lay down the basic principles and give guidance for systematic integration of the matters of environmental conservation in the sustainable development process;

(c) To emerge a healthy and clean environment and to conserve natural and cultural heritage;

(d) To reclaim ecosystems as may be possible which are starting to degenerate and disappear;

(e) To manage and implement for decrease and loss of natural resources and for enabling the sustainable use beneficially;

(f) To implement for promoting public awareness and cooperation in educational programs

(g) To promote international, regional and bilateral cooperation

(h) To cooperate with Government departments, organizations, international organizations, non-government organizations and individuals

Chapter III: Formation of Environmental Conservation Committee (ECC)

Article 4 (a): The Union Government shall form the Environmental Conservation Committee (ECC) with the Union Minister for the Union Ministry assigned by the Union Government as the Chairman and with suitable members to conserve the environment of the Republic of the Union of Myanmar;

Article 5: The Union Government shall stipulate functions and duties of the Committee to implement the objectives contained in this Law.

Article 6: The powers of ECC

(a) Carrying out educational activities;

(b) Suggesting to amend and insert, as may be necessary, the lessons on environmental conservation contained in school lessons;

(c) Accepting donations, grants, materials and technological aids, materials and technologies;

(d) Sending suitable suggestions and encouragements relating to environmental conservation;

(e) Asking necessary proposals and suggestions for conservation and enhancement of environment;

(f) Prohibiting the relevant Government departments and organizations if the environmental damages arise or situations for damage arise;

(g) Laying down and carrying out the Myanmar national environmental policies and other environmental policies for conservation and enhancement of environment

Chapter IV: Duties and Powers relating to Environment Conservation of the Ministry

Article 7: Duties and Powers relating to the Environmental Conservation of the Ministry are as follows:

(a) Implementing environmental conservation policies;

(b) Planning and laying down national or regional environmental management work plans;

(c) Laying down, carrying out and monitoring programmes for enhancement of the environment, and control of environmental pollution;

(d) Prescribing environmental quality standards

(e) Submission of proposals to the Committee for economic incentive mechanisms

(f) Specifying categories of hazardous wastes generated from the production and use of chemicals in industry, agriculture, mineral production, sanitation

(g) Promoting the establishment of necessary factories for the treatment of solid wastes, effluents and emissions which contain toxic and hazardous substances;

(h) Prescribing the terms and conditions relating to effluent treatment in industrial estates and other and emissions of machines, vehicles and mechanisms;

(i) Laying down and carrying out a system of environmental impact assessment and social impact assessment as to whether or not a project to be undertaken causing a significant impact on the environment;

(j) Cooperating with International, regional, bilateral agreements, instruments and programmes;

(k) Laying down guidance relating to Ozone layer protection, conservation of Biodiversity, of coastal, mitigation and adaptation of global warming and climate change, combating desertification and management of other environmental matters;

(l) Managing to cause the polluter to compensate for environmental impact, cause to contribute benefit from the natural environmental services, cause to contribute a part of the benefit from using the natural resources;

Article 8. Environmental Management Fund

To establish an Environmental Management Fund in the Union Budget for effective implementation of environmental conservation works in addition to the Union Consolidated Fund.

Chapter V: Environmental Emergency

Article 9: Committee shall immediately report to the Union Government to declare the occurrence of environmental emergency; carrying out necessary measures.

Chapter VI: Environmental Quality Standards

Article 10 : The Ministry may stipulate the following environmental quality standards:

(a) suitable surface water quality standards in the usage in rivers, streams, canals, springs, marshes, swamps, lakes, reservoirs and other inland water sources of the public;

(b) water quality standards for coastal and estuarine areas;

(c) underground water quality standards;

(d) atmospheric quality standards;

(e) noise and vibration standards;

(f) emissions standards;

(g) effluent standards;

(h) solid wastes standards;

(i) other environmental quality standards

Chapter VII: Environmental Conservation

The Ministry shall maintain a comprehensive monitoring system and implement in the

following matters:

the use of agro-chemicals which cause to impact on the environment significantly;

(a) transport, storage, use, treatment and disposal of pollutants and hazardous substances in industries;

(b) Disposal of wastes come out from exploration, production and treatment of minerals, industrial mineral raw materials and gems;

(c) Carrying out waste disposal and sanitation works;

(d) Carrying out development and constructions;

(e) Carrying out other necessary matters

Article 14: Compliance with Environmental Quality Standards

To treat and deposit the substances with cause pollution in accord with environmental standards;

Article 15: To install facility and equipment to reduce or eliminate environmental pollution;

Article 16: To comply with the directives in the industrial estate or business in the industrial and special economic zone;

Chapter VIII: Management of Urban Environment

Article 17: The Ministry shall, for the management of urban environment, advice as may be necessary to the relevant Government departments and Government organizations, private organizations and individuals in carrying out the following matters:

(a) land use planning and management including zoning;

(b) management of the construction industry in pivotal urban centers;

(c) management of housing settlements;

(d) management of wastes;

(e) pollution control including land, water, air and noise pollution;

(f) Other necessary environmental management.

Chapter IX: Conservation of Natural Resources and Cultural Heritages

Article 18: The relevant Departments and organizations shall carry out the conservation,

management, sustainable use and enhancement of regional cooperation of the following environmental natural resources:

(a) forest resources;

(b) land resources;

(c) fresh water resources including underground water;

(d) mineral resources;

(e) agricultural resources;

(f) fisheries resources;

(g) marine resources;

(h) natural ecosystems;

(i) natural areas, wildlife, natural plants and biological diversity;

(j) Other natural resources stipulated by the Union Government.

EIA procedures has newly come into effect in late 2015 . This procedures details the type of investment project whether requiring Initial Environmental Examination (IEE) or Environmental Impact Assessment .Hydropower Project which production capacity is greater than 15 MW requires to conduct EIA study .

3.3.5 Legislative and Institutional Framework related to Resettlement, Land Acquisition and Compensation

Guidance Notes on Land Acquisition in Myanmar were prepared by UNHABIT-UNHCR in 2010.This comprises of specific topics including salient legal features of land ownership in Myanmar. It is referable for the development and management of land in strategic plan of the township. Principle legislation concerning land acquisition are:

(a) Land Acquisition Act (1894)

(b) Farmland Law (2012)

(c) Farmland Rules (2012)

Current Laws and Regulations to be applied for Land issues mainly stated in the SIA part. It just describe a Brief Outlines of the Farmland Law, 2012 here.

The Farmland Law which was approved by the Union Parliament (Pyidaungsu Hluttaw) and signed by the President on 30th March, 2012 then come into force on 31st August, 2012. The

law provides the rights of farmers to a certain extent than the similar laws in the last 50 years. Some of the distinguished facts are:

Farmers will be granted the rights of farming certificate called Form – 7 for a particular land where they have been working previously by paying land revenue/tax to the government.

The farmer who has the right for farming certificate can sell, can lease, transfer or can ask a loan in a bank for their lands in line with the existing laws.

3.4 Proposed guideline and standards applied in the report

(1) Guideline

1) ENVIRONMENTAL ASSESSMENT GUIDELINES （Asian Development Bank）

2) Environmental Impact Assessment Guidelines （Ministry of Environmental Conservation and Forestry , The Republic of the Union of Myanmar）

3) National environmental quality (Emission) guidelines.

(2) Standards

1) Industrial Wastewater Effluent Standard of the Ministry of Industry (from Ministry of industry in Myanamr)

2) Guidelines for Drinking-water Quality, WHO 2008

3) National Recommended Water Quality Criteria – Correction, EPA 822-Z-99-001, 1999

4) Atmospheric environmental quality standards of Japan

5) National acoustic environmental quality standards of Thailand

6) Atmospheric emissio standards of Japan

7) Noise control standards of Thailand

（3） Target value

1) The environmental status standard value

The standards value to assess the environmental value is shown in the table3.4-1.

Table 3.4-1 Table of the water quality standard value

Parameter	unit	value
pH	--	6-9
DO	mg/L	≥5
BOD_5	mg/L	50
COD	mg/L	125
SS	mg/L	50
Cu	mg/L	1
SO_4	mg/L	250

S	mg/L	0.2
Fe	mg/L	0.3
Pb	mg/L	0.01
Hg	mg/L	0.0001
As	mg/L	0.01
fecal coliform	cfu/100ml	1000

2) Emission standard value

The emission standard value is shown in the table 3.4-2.

Table 3.4-2Table of Wastewater and Sanitary Discharges standard values

Parameter	Unit	Guideline Value
5-day Biochemical oxygen demand	mg/L	50
Ammonia	mg/L	10
Arsenic	mg/L	0.1
Cadmium	mg/L	0.1
Chemical oxygen demand	mg/L	250
Copper	mg/L	0.5
Iron	mg/L	3.5
Lead	mg/L	0.1
Mercury	mg/L	0.01
Oil and grease	mg/L	10
pH	S.U.a	6-9
Sulphide	mg/L	1
Total coliform bacteria	100 ml	400
Total suspended solids	mg/L	50
Zinc	mg/L	2

4 Project description and Alternative Selection

4.1 Overview of River Basin

Ngaw Chang Hka River is a first-class tributary on the left bank of midstream of Nmai Hka River and is located on the northern plateau of Myanmar. Except the reach of the China-Myanmar boundary river, all the other reaches of the main stream of Ngaw Chang Hka River are located in the Kachin State of Myanmar. Originating from the place near the Jiaedu Pass of Gaoligong Mountain, the river typically has an U-shaped river course, Its upstream flows from northeast to southwest, the midstream from east to west and the downstream from south to north. It flows into Nmai Hka at about 1.5km at the downstream of Mijiao. Ngaw Chang Hka River has the river head elevation of about 3900 m a.s.l., and the confluence elevation of about 342.5 m a.s.l. into the Nmai Hka River, with a natural drop of 3557.5 m, a total main stream length of about 144.6 km, and an average slope of 24.6‰.

Ngaw Chang Hka River Basin has a plentiful river system, with a basin area of about 2507 km^2. Its relatively large tributaries include Mo Ku Chaung River, Mung lang Hka River, Chai maw Hka River, Lawng maw Hka River and so on.

The reaches to be developed are the downstream part of the China-Myanmar boundary river. Generally, the terrain in the area is high in east and north but low in west and south. The elevations of most mountain peaks in the middle and east are higher than 3,000 m a.s.l. The Yhi mo Beng mountain peak has the highest elevation of 4,075 m a.s.l. The planning river reache has an elevation of 1510–640m a.s.l. at the valley bottom, and an elevation of about 342.5 m a.s.l. at its confluence into the Nmai Hka River. The landform characteristics in the area are dominated by erosion and denudation, with medium-high mountains. Main mountains and rivers are controlled by geological structures in NNE direction. Both banks of the river course have developed gullies, with relatively poor landform integrity. The river course has a large slope and narrow surface. Alluvial and diluvial constructional terraces only develop in some river reaches.

4.2 Overview of River Hydropower Development Plan

According to *The Report on Key Points of Hydropower Planning for Ngaw Chang Hka River* and latest agreement between Myanmar government and YPIC, a four-cascade(including Gawlan, Hkankawn, Tongxingqiao, and Lawndin) development scheme for the planning river

reaches will put into practice, with a planned total installed capacity of 1,200MW. The geographic position of the cascades is shown in attached map 1 below.

4.3 Geographical Location of Tongxinqiao HPP

Tongxinqiao HPP is the 3rd-cascade in the planned cascades for the Ngaw Chang Hka River.

The dam site is located at about 320m downstream of the confluence between the Pailai River and the Ngaw Chang Hka River, which is 56km away from the Banwa port. The main access route is planned as follows: Kunming ~ Anning ~ Chuxiong ~ Dali ~ Lancang River Bridge ~ Baoshai

Kunming to Tongxinqiao dam site is about 787km. the sketch map of access roads is shown in attached map 2.

4.4 Necessity for Project Construction

Construction of Tongxinqiao HPP, with advantage indicators of technical-economic, is in conformity with the energy policy of Myanmar. It will play an important role in satisfying the increasing local electricity demand, accelerating the economic development of Myanmar, improving the living standard of local people, creating comprehensive benefits of environmental-protection, and energy-saving and emission reduction.

4.5 Comparison and Selection of the alternatives

At the feasibility study stage of the project, we conducted extensive comparison and selection of engineering schemes, including the comparison and selection of dam site and powerhouse site.

4.5.1 Dam Site alternative

According to the topographic-geologic conditions and water resources of the planned river reach, two alternative dam sites, as well as its representative project layout schemes, were proposed in same depth for comprehensive comparison in the previous stage .The upper dam site was finally recommended as a result of the comparison, and also in combination with the experts' consulting opinions.

(1) Complex layout scheme for the upper and lower dam sites

The river channel of the upper dam site is simply straight. and the representative dam-type is

concrete gravity dam, with flood releasing structures centralized at the riverbed dam blocks and power intake at the R/B dam section. The complex project layout is consists of following main structures: concrete gravity dam, overflowing dam, L/B and R/B bottom releasing orifices, dam-type intake, headrace tunnel, surge shaft, penstock and ground powerhouse.

The river course of the lower dam site is relatively narrow and turns from east to west, its representative complex layout is constituted as following structures: concrete facing rockfill dam, L/B spillway, R/B flood releasing tunnel, R/B power intake, headrace tunnel, surge shaft, penstock and ground powerhouse.

(2) Main conclusion of comparison

1) Topographic condition

The water surface width of the upper dam site during the low-water season is about 20m, while that of the lower dam site is about 47m; the water surface elevation of the lower dam site is about 60m lower than that of the upper dam site; At the same FSL of El. 1,075m, the water surface width of the upper dam site is about 120m, and that of the lower dam site is about 300m, the resulting dam height and quantity of lower dam site is much more large than the upper dam site. Accordingly, the upper dam site is better than the lower dam site from the perspective of topography.

2) Engineering Geologic Conditions

Engineering geologic conditions of both the upper and the lower dam sites are relatively good for building 100m-high dams. Comparatively speaking, the engineering geologic condition of the lower dam site is more complicated with following problems: slope stability of dam abutment, surrounding rock stability of tunnel inlet section and relatively large anti-seepage treatment quantity of dam foundation. Therefore, from the geologic perspective, geologic problems of the upper dam site are relatively simple and easy to handle.

3) Complex layout and construction conditions

The complex layout of both the upper and the lower dam sites are feasible with no any technical difficulty. The maximum dam height of concrete gravity dam adopted by the upper dam site is 63m, and the dam crest length is 173m, while the maximum dam height of the CFRD on the lower dam site is 124m and the dam crest length is 330 m, the dam size of the

upper dam site is relatively smaller than the lower dam site; However, the length of the headrace tunnel for lower dam site is about 7.5km, which is 2.1km shorter than that of the upper dam site.

Both the two dam sites are basically identical and have no obvious difference in the following aspects of construction diversion, planning of material sources, construction of principal works, construction transportation, master construction layout and master construction programme.

Thus in terms of complex layout and construction conditions, the upper dam site is superior to the lower dam site obviously.

4) Energy indicators

Because of more storage capacity and shorter headrace tunnel, the guaranteed output and perennial average energy productivity of the lower dam-site could be increased by 1.2MW and 12 million kWh respectively in comparison with that of the upper dam-site.

5) Environment impact

Although, neither of the damsites involves environmental sensitive objects such as conserved forests of Myanmar, but both the reservoir submerging and land occupation of the lower dam site are larger than that of the upper dam site. Considering its large scale of dam, the project layout of the lower dam site has much more impacts and disturbance on the environment.

Therefore, with the technology, economy and environment features of both two alternative dam sites took into consideration, the upper dam site is recommend as the construction dam site for Tongxinqiao HPP.

4.5.2 Powerhouse Site alternative

Based on the topographic and geologic conditions of the planned river reach, the preliminary powerhouse site(refered as the lower powerhouse site below) is about 340m U/S of Ve Lat Village, with a river length of about 14.7km away from the selected dam site.

In addition, the upper powerhouse site, which is about 2.5km U/S of the lower powerhouse site, had been proposed for comparison during the feasibility study stage.

Based on the selected dam site, amounts of investigation and analysis work had been

conducted to compare the upper and the lower powerhouse sites, main conclusions had been achieved as follows.

（1） Complex Layout of the upper and lower powerhouse sites

The lower powerhouse site is characterized with a gently terrain slope and a relatively thicker overburden. In contrast, the upper powerhouse site is topographically steeper and with thinner overburden.

Based on the selected dam site and concrete gravity dam, the complex layout pattern is basically identical for the two alternative powerhouse sites.

（2）Main conclusion of comparison

1） Topographic Conditions

Both two powerhouse sites have the topographic conditions for arrangement of ground powerhouse.

2）Engineering Geologic Conditions

Without influence of Grade I geological structure (Fault F2) and relatively large gullies, the engineering geologic conditions of the upper powerhouse site are better than those of the lower powerhouse site. However, both the alternative sites can meet the requirements for building powerhouse and relevant structures.

3）Complex layout and construction conditions

The complex layout of both the comparison powerhouse sites are feasible in technique. Relatively speaking, the headrace tunnel of the upper powerhouse site is about 1.4km shorter than the lower powerhouse site, while the penstock is about 400m shorter. Moreover, the construction conditions for the two powerhouse sites have no obvious difference. So from the perspective of complex layout and construction conditions, the upper powerhouse site is superior to the lower powerhouse site.

4）Energy indicators

With a less utilization waterhead of 29m, the installed capacity and guaranteed output for the upper powerhouse site is less than those for the lower powerhouse site relatively.

5) Static economic indicators

Accordingly, the economy index for the lower powerhouse site is much better than that for the upper powerhouse site.

6) Comparison of environmental impacts

With no restrictive elements in the area, the environmental features for the two comparison sites are almost the same. However, in view of shorter headrace tunnel and less excavation, the upper powerhouse site has less environmental impacts than the lower site.

Comprehensively took the above aspects into consideration, the lower powerhouse site is recommended as the selected powerhouse site of Tongxinqiao HPP.

4.6 Description of the selected alternatives

4.6.1 Development task of the Project

The development of the Tongxinqiao HPP is under the natural conditions that both banks at the river reaches are dominated by mountains and canyons, the river slope is high and the flow regime is disordered, where it is impossible to develop navigation business and there are on requirements on development of navigation business. Residents are scattered at both banks at the river reaches. Cultivated land is in a relatively small area on both banks. Domestic water and water for irrigation are mainly sourced from abundant local mountain spring. As for the Tongxinqiao HPP, there are no requirements on water supply and irrigation. Besides, restricted by the topographic conditions for construction of reservoir, the reservoir of the Tongxinqiao HPP has a relatively small effective storage, and the reservoir has no function of flood control.

To sum up, the task of Tongxinqiao HPP is power generation.

4.6.2 Project Scale

The total reservoir storage of this HPP is $552\times10^4 m^3$ and the installed capacity is 340MW. This HPP is a class II large (2) project. The main structures (concrete gravity dam, flood releasing and sand flushing structures, and headrace and power generation structures) are of grade 2; the downstream energy dissipation and protection works and the secondary structures are of grade 3; the temporary structures are of grade 4.

Project scale: the installed capacity of 340 MW, normal water level of reservoir of 1,075m a.s.l., and corresponding reservoir storage of 5.14 million m^3. The main engineering characteristics is seen in Table 4.6-1.

Table 4.6-1 Main Engineering Characteristics of Tongxinqiao Hydropower Project

S/N	Name	Unit	Qty.	Remarks
I	Hydrology			
1	Drainage area			
	Drainage area above the dam site	km^2	1,743	
2	Hydrological system utilized	year	49	
3	Annual mean runoff	10^9m^3	4.26	
4	Representative flow			
	Average annual flow	m^3/s	135	
	Design flood discharge (P=1%)	m^3/s	2,300	
	Checked flood discharge (P=0. 1%)	m^3/s	3,090	
	Design flood discharge of plant building (P=1%)	m^3/s	2,460	
	Discharge of downstream energy dissipation and anti-scour facilities (P=2%)	m^3/s	2,060	
	Construction diversion discharge (P=5%)	m^3/s	1,740	
5	Sediment			
	Annual mean sediment discharge of suspended load	10^3t	872	
	Annual mean sediment discharge of bed load	10^3t	131	
	Annual mean sediment concentration	kg/m^3	0.205	
II	Reservoir			
1	Reservoir water level			
	Checked flood level (P=0.01%)	m	1076.19	
	Design flood level (P=0.1%)	m	1071.84	
	Normal water storage level	m	1075	
	Dead water level	m	1060	
2	Reservoir area at normal water storage level	km^2	0.32	
3	Length of back water	km	2.65	
4	Storage capacity of reservoir			
	Storage capacity at normal water storage level	10^6m^3	5.14	
	Regulation storage capacity	10^6m^3	3.51	
	Dead storage capacity	10^6m^3	1.63	
5	Coefficient of storage capacity	‰	8.2	
6	Regulatory performance	Daily regulation		
7	Utilization coefficient of water flow	%	65.85	
III	Leakage flow and corresponding downstream level			
1	Maximum leakage flow at design flood level	m^3/s	2,300	
	Corresponding downstream level	m	1045.69	
2	Maximum leakage flow at Checked flood level	m^3/s	3,090	
	Corresponding downstream level	m	1048.05	

S/N	Name	Unit	Qty.	Remarks
IV	Indices of project benefit			
1	Power generation benefit			
	Installed capacity	MW	340	
	Guaranteed output	MW	50.73	
	Annual mean generating capacity	GW•h	1.695	
	Annual operation hours of installed capacity	h	4986	
V	Land requisition for construction and migrants resettlement			
1	Inundated farmland	ha	0.23	
2	Inundated woodland	ha	16.64	
3	Relocated population	Person	222	
4	Houses demolished	m^2	1,240	
VI	Main structures and equipment			
1	Water retaining structures			
	Type	Concrete gravity dam		
	Foundation features	Granite		
	Basic seismic intensity/fortification intensity	degree	VIII/ VIII	
	Elevation of dam crest	m	1078.00	
	Maximum dam height	m	63.0	
	Length of dam crest	m	173	
2	Discharge structures			
(1)	Crest overflowing orifices			
	Type		WES curve practical weir	
	Elevation of weir crest	m	1065.00	
	Number of holes-size (width×height)	m	3-7×10	
	Method of energy dissipation	Underset energy dissipation		
	Type, size and quantity of work gate	3-7×10		
	Type, quantity and capacity of headstock gear	1 portal crane, 3 hydraulic headstock gears		
	Design flood discharge	m^3/s	713	
(2)	Left bottom discharge and flushing horifice			
	Sill elevation	m	1041.00	
	Number of holes-size (width×height)	m	1-5×8	
	Method of energy dissipation	Trajectory bucket type energy dissipation		
	Type, size and quantity of work gate	1-5×8		
	Type, quantity and capacity of headstock gear	1 stationary winches,2000/500 kN		
	Design discharge flow	m^3/s	757	
	Checked flood discharge	m^3/s	816	
(3)	Right bottom discharge and flushing orifice			
	Sill elevation	m	1036.00	
	Number of holes-size (width×height)	m	1-5×8	
	Method of energy dissipation	Trajectory bucket type energy dissipation		
	Type, size and quantity of work gate	1-5×8		
	Type, quantity and capacity of headstock gear	1 stationary winches,2000/500 kN		
	Design flood discharge	m^3/s	757	

S/N	Name	Unit	Qty.	Remarks
	Checked flood discharge	m^3/s	816	
3	Diversion generation structures			
	Design diversion discharge	m^3/s	154	
(1)	Power intake			
	Type	Bank-tower type		
	Foundation features		Granite	
	Sill elevation	m	1046.00	
	Type, size and quantity of work gate	m	1-7.5×8	
	Type, quantity and capacity of headstock gear	1 stationary winch, 1 stationary cleaning machine		
(2)	Conduit tunnel			
	Type	Circular pressure tunnel		
	Lithology of country rock	Granite		
	Length	m	9,600	
	Tunnel diameter	m	7.5	
	Lining type	Reinforced concrete lining		
	Design water head	m	260	
(3)	Surge shaft			
	Type	Restricted orifice-upper-chamber type surge shaft		
	Lithology of country rock	Granite		
	Shaft diameter	m	16	
	Type, size and quantity of emergency fast gate		1-5.8×5.8	
	Type, quantity and capacity of headstock gear	1 hydraulic headstock gear		
(4)	penstock			
	Type	Deeply buried penstock		
	Number of pieces		1	
	Length of main pipe	m	980	
	Inner diameter of main pipe	m	5.8	
	Max. head	m	350	
4	Powerhouse			
	Type	Bankside type		
	Foundation features			
	Dimension of main powerhouse	m	68×19×47	Length×Width×Height
	Installation super elevation of water turbine	m	774	
5	Switch station			
	Type	Ground GIS switch station		
	Dimension of GIS building	m	68×15×33.7	Length×Width×Height
	Area (length×width/number of floors)	m^2/floor	1020	
6	Main electromechanical equipment			
(1)	Water turbine			
	Qty.	Set	2	
	Model	HL100-LJ-415		
	Rated output	MW	173.5	
	Rated speed	r/min	250	
	Suction height	m	-6.1	
	Max. head	m	292	
	Min. head	m	257	
	Rated head	m	260	
	Unit rated flow	m^3/s	72.9	
(2)	Generator			

S/N	Name	Unit	Qty.	Remarks
	Qty.	Set	2	
	Model	SF170-24/7400		
	Rated capacity	MW	194.3	
	Power factor		0.875	
	Rated voltage	kV	15.75	
VII	Construction			
1	Main works volume			
	Open cut of earth and stone works	10^3m^3	1207	
	Tunneling of stonework	10^3m^3	664	
	Concrete and reinforced concrete	10^3m^3	376.7	
	Shotcrete	10^3m^3	30.4	
	Reinforcement bar	10^3t	20.07	
	Steel	10^3t	11.192	
	Consolidation grouting	10^3m	45.8	
	Backfill grouting	10^3m^2	100.8	
2	Main building materials			
	Wood	10^3m^3	5.26	
	Cement	10^3t	135.73	
3	Necessary labor			
	Total man-day	10^3 man-day	1462.7	
	Number of persons of annual mean period	Person	1,585	
4	Temporary construction house	m^2	41400	
5	Power for construction and supply		Diesel generating, Pianma power supply	
	Power supply	kW	3120	
	Other power equipment	kW	250	Diesel generating station
6	External transportation			
7	Construction diversion			
	Type		River diversion tunnel	
	Section type		City-gate-shaped	
	Size		8×10	
8	Construction period			
	Preparation period	Month	6	
	Operation period of the first generator set	Month	41	
	Total construction period	Month	51	

4.6.3 Project Layout and Main Structures

According to the Feasibility Study Report, the selected project layout of Tongxinqiao HPP is mainly composed with following three parts. The general plane layout of the project is shown in Attached map 3.

4.6.3.1 Header project

The header project is consists of the water retaining structure and the water releasing structures.

On the basis of topographic and geological conditions of the damsite, concrete gravity dam was adopted as the water retaining structure, with a total length of 173m and a maximum height of 63m. The elevation of dam crest is 1078m. The basic profile of the dam body is triangular and the downstream dam slope is 1:0.7.

Crest overflowing orifices on the river bed are the main flood releasing structure of the project. There are 3 crest overflowing orifices with the dimension of 7m×10m (W×H) and the weir crest is at EL.1065.00m. A bulkhead gate and a radial service gate are installed on the weir.

Besides, two bottom discharge and flushing orifices are arranged on both sides of the overflowing dam blocks, with the bottom elevation of 1041.00m and radial work gate size of 5m×8m. The relevant maps are shown in attached maps. The environmental status can be seen in photo below.

Attached map 4 shows the Plane Layout of the Gravity Dam.

Attached map 5 shows the Upstream Elevation of the Gravity Dam.

Attached map 6 shows the Cross Section of the Crest Overflowing Damblock.

Attached map 7 shows the Cross Section of the Bottom Flushing Damblock.

4.6.3.2 Headrace tunnel

(1) The composition

Considering the landform and geographic conditions and general project layout, the headrace tunnel is located in the mountain body on the right bank and composed of intake, conduit tunnel, surge shaft and steel penstock.

Determined with a bottom elevation of 1046.00m, the water intake of the headrace tunnel is arranged within the R/B non-overflowing dam block. Four trash racks and one bulkhead gate for accident are set at the water intake. The orifice dimension of trash rack is 3.85 m×14.5m (W×H) and that of accident maintenance gate is 7.5m×8.0m.

The water supply mode of "one tunnel for two generator sets" is employed in consideration of economic. The diversion discharge of the tunnel is 154m^3/s. The conduit tunnel is about 9,600m long, with a internal diameter of 7.5m. With the bottom elevation of 1006.00m, the surge shaft is close to the power house. The determined inner diameter of the shaft is 13.0m.The embedded steel penstock shall be employed for the penstock. And the total length of the main pipe is 980m, with a relatively small internal diameter of 5.8m.

(2) the simple environmental status around the headrace tunnel area

The tunnel is buried underground. It is totally 9600 meters long. It will be built from the adit separately. There are 6 adits, which can be constructed at the same time.

It was the mountain rugged topography in this area. The vegetation is well. Considering are no people living in this area, the atmosphere and acoustic environment is good, which the construction impacts will be weak in this area. In other side, the construction is conducted underground, which just through the adits and external road to affect the environment. According to the survey, the landuse type in this area is mainly wood land. The status in this area can be seen in the photo below.

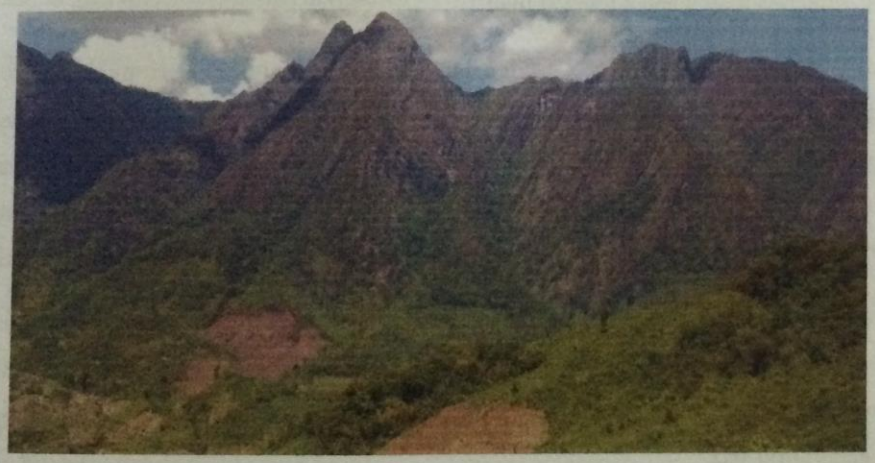


Photo: The landform around the headrace tunnel

The longitudinal profile of headrace structures is shown in Attached map 8.

4.6.3.3 Power generation system

Powerhouse is located on the hillside on the right bank, composed of buildings such as ground powerhouse, GIS switch room and tail water channal. The cross section of powerhouse is shown in Attached map 9 and Attached map 10.

The clear width of the main powerhouse is 20m. The spacing between generation units is 18m, the total length is 45m and the height is 51m. There are 2 water-turbine generator sets with a unit installed capacity of 170MW in the powerhouse. The installation elevation of the water turbine is 774.0m. The erection yard is located on the left end of the main powerhouse. Auxiliary powerhouse shall be arranged parallel to the upstream and downstream sides of the main powerhouse.

Elevation of the operating platform of the tail water gate is 791.00m. One bulkhead gate shall be set for each generation set, while one plane slide gate shall be set for the common usage of the two generation sets.

The bottom elevation of the tail water pipe is 761.70m, lower than the river bed. The tail water channel shall be constructed to lead the tail water into the river course smoothly.

4.6.4 Construction Planning

4.6.4.1 General Construction Layout

According to the characteristics of topography and general layout of hydraulic structures, the project general construction layout can be divided into dam, headrace system, and powerhouse construction areas, based on the construction requirements, shown as in Attached map11

.According to the material source planning, the concrete coarse aggregate will be processed by useful excavated materials of headrace tunnel, while fine aggregate made from stone quarry on the mountain behind Nanmu street. In consideration of haul distance and construction convenience, 3 artificial aggregate systems and 2 concrete mixing systems are arranged close to the dam and powerhouse construction areas.

Meanwhile, 2 stockpile&spoil disposal areas and 2 spoil disposal areas are arranged in the project area, based on the excavation location and material planning.

In addition, total of 6 construction adits are arranged for the headrace tunnel and steel penstock to guarantee its construction schedule.

4.6.4.2 Quarry

The material souce utilization of Tongxinqiao HPP. is planned in accordance with the prior principle of fully use the excavation material, so as to maximum reduce the environment impacts and disturbance. However, as a supplementation, stone quarries of Tongxinqiao and Nanmu Street have been selected at the same time for the construction.

Tongxinqiao quarry is about 1.0km downstream away from the dam site. The stone material is medium-coarse granite, with a estimated available reserve of $200\times10^4m^3$.

Nanmu River quarry is approximately 2.4km from the plant site in terms of straight-line distance. The stone material is marble, with a estimated available reserve is $300\times10^4m^3$.

In consideration of loss during quarrying, transportation and processing, the planned total quarrying volume for the project is about $45\times10^4m^3$, including $37\times10^4m^3$ usable and $8\times10^4m^3$ stripping.

The planning stone quarrying process is briefed as follows: firstly to strip the useless layer of highly weathering rock, then quarrying the useful layer in layers and benches with a

combination method of side wall presplitting, deep hole bench blasting. The stone materials are collected by bulldozers, loaded by 3.0m^3 loader and transported by 15t dump truck to the aggregate processing system.

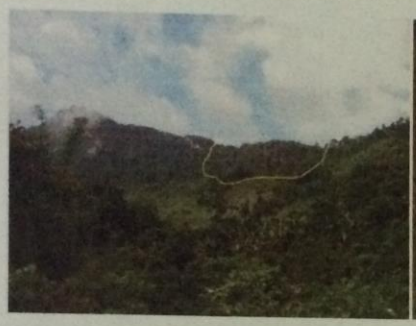
According to the field investigation the land cover is thin forest and shrub vegetation in both quarries. The photos below are about the two quarries of the projects, where the surrounding environmental conditions can be depicted as below:

1) The topography is steep around the quarry.

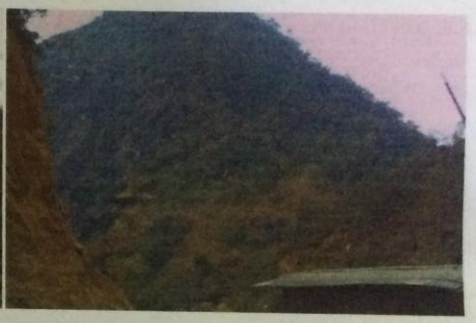
2) There is no thick vegetation on the quarry.

3) Considering there is no big industry around this area, it is good quality both to the air and acoustic environment.

4) There is no more villages near the quarries except a house near the tongxinqiao quarry.



The Nan mu street quarry



The Tongxinqiao Quarry

4.6.4.3 Aggregate processing system

Three aggregate processing systems are set up to supply all the concrete coarse and fine aggregate, according to the general construction layout planning.

The coarse aggregate processing system for the head complex is located close to the stockpile and spoil disposal yard 2, for preparation of coarse concrete aggregate for the diversion works, dam works, intake works and partial headrace tunnel works, with a coarse crushing capacity of 160t/h and finished capacity of coarse aggregate of 120t/h.

The coarse aggregate processing system for the powerhouse is located close to the permanent bridge of the powerhouse, for preparation of coarse concrete aggregate for the powerhouse works, surge shaft works, steel penstock works and partial headrace tunnel works, with a

coarse crushing capacity of 100t/h and finished capacity of coarse aggregate of 80t/h.

The fine aggregate processing system is located close to the quarry of Nanmu River, for preparation of fine concrete aggregate for the whole project, with a coarse crushing capacity of 120t/h and capacity for finished products of 100t/h.

4.6.4.4 Concrete Production System

Two concrete production systems are set for the head complex and powerhouse. Three simple concrete mixing stations are set at the adits 1, 2 and 3 of the headrace tunnel.

The head complex concrete production system is located at the right bank of the construction bridge, for the diversion works, dam works, intake works and partial headrace tunnel works. The normal temperature concrete production capacity of the system is $90m^3/h$, and the pre-cooled concrete production capacity is $60m^3/h$ (outlet temperature of 14℃). One HZ120-2F3000 concrete batching plant is provided, with other primary facilities such as air-cooling, ice-making and water-cooling.

The powerhouse concrete production system is located close to the permanent bridge of the powerhouse at the right bank, adjacent to the powerhouse coarse aggregate processing system, for production of concrete for the powerhouse works, surge shaft works, steel penstock works and partial headrace tunnel works, with a design production capacity of $55m^3/h$, and equipped with one HZ75-2F1500 concrete batching plant.

The headrace tunnel concrete batching plants are located respectively at the adits 1, 2 and 3 of the headrace tunnel, each has a design production capacity of $9m^3/h$ and a JZ350 concrete mixers.

4.6.4.5 Water Supply System

The construction water is supplied from the Ngaw Chang Hka River, and each water supply system will be set in the vicinity of dam and powerhouse, with a total water supply capacity of $900m^3/h$.

Besides, in order to meet the water quality requirements for different users, all the water supply systems are equipped with the corresponding purification devices.

4.6.4.6 Stockpile and Spoil Disposal Yards

The four stockpile and spoil disposal yards are planned with a total capacity of $234.26\times10^4m^3$

(un-compacted). Except a part of rock material excavated from structures will be utilized as concrete coarse aggregate by processing, the other excavated materials will be disposed as waste, and the total waste volume is estimated about $181.89\times10^4m^3$ (un-compacted).

4.6.4.7 Construction Diversion

For the head complex construction, the low water period cofferdam and tunnel diversion mode is recommended.

In the first dry season after river closure, the river will retained with the upstream and downstream earth-rock cofferdams and discharged through the diversion tunnel. And then before the first flood season, the upstream and downstream cofferdams are removed to release water through the preseted dam gap. In the second dry season, the upstream and downstream cofferdams will be rebuilt again for water-retaining, then removed before the second flood season, by the time, the river will be retained by the temporary dam section and discharged through the diversion tunnel and bottom flushing orifices.

4.6.4.8 Impounding Plan

According to the overall construction schedule and diversion plan, the diversion tunnel will be plugged by gate for impounding during the first ten-day period of May in the 5th year. According to calculation, it will take 13.4 hours for the reservoir to impound up to the dead water level of 1060.00 m a.s.l.

4.6.4.9 Worker's Accommodation Plan

The accommodation is arranged in the construction and owner's camp for all the personnel participating the construction and operation. The overview of the plan is that the living quarters are 3 4-floor's buildings in Owner's camp and the potable house for the construction camp, which is planned for 2 people a room. While there will be a mess hall in every camp at least, which it can provide the repast for all workers.

4.6.4.10 General Schedule

(1) Construction phase

Divided into the period for preliminary works, project preparation period, period for construction of main works and period for completion, the total construction period of Tongxinqiao HPP is 51 months, in which the project preparation period is 6 months, the period for construction of main works is 41 months and the period for completion is 4 months.

And the construction period of the first generate unit is 47 months.

(2) Operation phase and decommissioning

The developer will operate the Project for nearly 40 years, which is decided by the JV agreement. As to when to decommission, it depends on the Myanmar government. After closing stage, The dam, powerhouse and other unuseful facilities will be dismantled, and the land will be recovered, which it will be requirements to carry out new EIA studies.

4.6.5 Land Acquisition and Resettlement Planning

4.6.5.1 Indexes

Based on the investigation results during the feasibility study stage, the construction land of Tongxinqiao HPP is 4.58 km^2, in which the land area is 4.45 km^2, and the water area is 0.13km^2. The agricultural land is 411.80 hm^2, including the farmland of 90.67hm^2, garden of 9.48hm^2 and forest of 311.65hm^2, construction land is 13.23hm^2, Sand beach and water area 33.07 hm^2. There is a village residential area within the scope of construction land, with a population of 222 persons and building area of 3180m^2. Simple roads involved are 18.02km, with a length of 55m's bridge.

According to the laws and regulations of Myanmar government and MOA, it is MOEP's responsibility to get the approval document of the landuse after JV Company has been established.

(1) Indexes in kind of reservoir inundation impact zone

The land for reservoir inundation zone of Tongxinqiao HPP is 0.306km^2, in which the land area is 0.182km^2, and the water area is 0.124km^2. The agricultural land occupied is 16.87hm^2, including the farmland of 0.23hm^2 and forest of 16.64hm^2; the unutilized land is 13.76hm^2. No village residential areas, population, buildings and special works involved in the reservoir inundation.

(2) Indexes in kind of hydro-project construction area

The total land area of hydraulic structure construction zone is 3.565km^2. The agricultural land occupied is 323.96hm^2, including the farmland of 17.9hm^2, garden of 9.48hm^2 and forest of 296.58hm^2. There is a village residential area within the scope of land, with a population of 216persons. The building area is about 1,840m^2; the simple roads involved are 18.02km and a length of 55m's bridge is involved.

4.6.5.2 Resettlement Planning

The resettlement plan includes the livelihood restoration part and preliminary relocation and construction plan of the residential area.

(1) Livelihood restoration

For the residents with the land (such as farmland) affected by the construction, the land transformation and development cost shall be charged according to the standard of the equivalent land resources to the occupied land, for land reclamation and development of farmland and gardens conducted nearby, and the farmland lost due to construction shall be supplemented to restore the main means of livelihood. For the project-affected people without land resource originally, the personal property shall be compensated reasonably for finding their own means of livelihood.

(2) Relocation and construction of residential area

The project-affected people will lose their personal properties due to construction, such as houses. It shall be compensated at one time according to the replacement cost of the personal properties and homestead, and with other relevant subsidies, and the project-affected people shall move and re-build houses at the resettlement site.

The resettlement population for the base year (2010) of Tongxinqiao HPP is 208 (all are within the construction zone of the hydraulic structures), and deduced resettlement population for the design level year (2013) is 216.

(3) Reservoir Bottom Clearing

The scope of reservoir bottom cleaning is determined based on the scope of reservoir inundation treatment, objects of clearing, reservoir operation mode and the comprehensive utilization requirements of the reservoir. The general range of clearing is the reservoir inundation zone below 1,075m.

4.6.6 Main construction material and others

(1) Many local material will be get from the quarry, soil yard, the tunnel and other projects excavation and so on.

(2) Major external supplies of the Project are cement, admixture, steel, fuel, etc., which shall mainly be transported from various manufacturers to the power station via highway.

The combined transportation mode of railway and highway shall be adopted for major and heavy articles of the Project which are considered to be supplied from China. Major and heavy articles shall be transported from the manufacturer to Dali transfer station via railway, of which the mileage of Kunming-Dali is 379km, and then highway transportation from Dali to the power station shall be adopted (it shall pass on the original Grade III and IV provincial and county highway in China, with total mileage of 446km). Bridges and culverts along several highway sections in China shall be strengthened so as to meet the transportation requirements for major and heavy articles of the Project.

The external transportation of Tongxinqiao Hydropower Project in Myanmar is simple highway, in order to meet the transportation requirements of materials and major and heavy articles for the power station, the simple highway from Myanmar to Tongxinqiao powerhouse site, of which in Myanmar part (including bridge and culvert) shall be reconstructed and expanded in accordance with Hydropower Engineering Grade III highway standard in China. Reconstruction/expansion mileage of external transportation is 60km. It is clay bound macadam, with pavement width being 6.5m and subgrade width being 7.5m.

Timber is considered to be supplied by the local organization. Except that, steel products, initiating explosive materials and oil shall be supplied from China. The products of Kunming Iron and Steel Group Co. Ltd can be considered for the steel products, initiating explosive materials can be supplied by the local departments and oil can be supplied from Tengchong. The explosive will be stored and used with special requirement, meeting the safety and environmental demand.

The annual and total used amount of materials is shown in the table 4.6-2.

Table 4.6-2 Main construction Materials supply indexes in each year

Items	Unit	The annual amount					Total
		1st year	2nd year	3rd year	4th year	5th year	
Cement	t	29353	40850	3710	123590	26860	224363
Steel	t	3000	6780	17470	22360	4190	53800
Wood	m^3	284	524	274	3307	1535	5942
Explosive	t	300	448	758	424	35	1965
Fuel	t	910	1100	2710	1210	710	6640

(3) Construction machines

Table 4.6-3 Proposed main construction machines

SN	Items	Specification and type	Unit	Quantity	Remarks
1	Excavator	$1.2m^3$~$1.5m^3$	Set	23	
2	Excavator	$0.5m^3$	Set	8	
3	Pneumatic drill	YT24	Set	60	
4	Down-hole drill	Φ100mm~150mm	Set	16	
5	Raise-boring machine		Set	3	
6	Dump truck	20t	Truck	28	
7	Dump truck	15t	Truck	68	
8	Heavy motor truck	5t	Truck	16	
9	Three-arm drilling jumbo		Set	8	
10	Wheel loader	$3m^3$	Set	13	
11	Side dump loader	$2.15m^3$	Set	7	
12	Shotcrete machine	Rotary type, $3m^3/h$~$6m^3/h$	Set	12	
13	Concrete agitator truck	$6m^3$	Truck	33	
14	Concrete pump	$60m^3/h$	Set	12	
15	Inverted arch jumbo		Set	5	
16	Steel die jumbo		Set	5	
17	High-pressure jet hydraulic jumbo	CYP50	Set	4	
18	Double barreled vertical grout mixer	200L	Set	24	
19	Plunger type slurry pump	BW250-50	Set	24	
20	Boring machine	CJ-3	Set	6	
21	Grouter	GBW-100/100	Set	6	
22	Vibratory flat grinding	16t	Set	4	
23	Vibratory padfoot roller	16t	Set	4	
24	Tower Crane	10~30t	Set	2	
25	Crawler crane	QU20	Set	4	
26	Horizontal vessel	$3.0m^3$	Set	6	
27	Blower fan	55 kW	Set	6	
28	Blower fan	75 kW	Set	10	
29	Submersible pump	150QJ20-52	Set	30	

The worker in construction phase on average is 1450. It is 1950 workers in rush hour. The worker team is constituted by international and domestic workers. The composition of worker is shown in table 4.6-4, 4.6-5.

Table 4.6-4 Proposed composition list in construction phase

No.	Category	Chinese	Myanmar	Remarks
1	experts	60	30	
2	Construction manager	150	50	
3	Electromechanical equipment and installment	65	25	Advanced skilled worker : 100% Chinese Skilled worker: 70% Chinese : 30% Myanmar Semiskilled worker: 50% Chinese : 50% Myanmar Common worker: 30% Chinese : 70% Myanmar
4	Metal structure equipment and installment	35	15	
5	Civil works	1045	375	

No.	Category	Chinese	Myanmar	Remarks
6	Other	75	25	
	Total	1430	520	

Table 4.6-5 Proposed worker composition in operation phase

No.	Category	Chinese	Myanmar	Remarks
1	Manager	27	9	
2	Generator operation	33	12	
3	Hydrological engineer (hydraulic monitoring)	7	3	
4	Water affairs	4	2	
5	communication	1	1	
6	Store clerk=	3	1	
7	Driver	6	3	
	Total	81	31	

(4) Inport duty

As to the import duty of many kinds of material and big machines for construction, it will be decided in the Joint Venture negotiated as cost of the project. According to the foreign investment law, it will be duty free in the limited period.

5 Baseline of the Surrounding Environment

5.1 The Study limits

(1) The range for assessment of water environment is from the reservoir tail of Tongxinqiao HPP to 500m D/S of the powerhouse, including the tributaries flowing into the river reach, and the key assessment area is the water reducing reach from the dam site to the powerhouse of the HPP.

(2) The assessment range of atmospheric and acoustic environment is the area wwithin 200m extending outward from the construction land acquisition line.

(3) The assessment range of terrestrial ecosystem is as follows: within the range under the first ridge line on both banks between reservoir tail to powerhouse site, and within the range of 500m extending outward from the construction land acquisition line of the project, and the key investigating area is the reservoir submerging area and the construction land occupation area.

(4) The assessment range of aquatic ecosystem is as follows: the entire basin of Ngaw Chang Hka River, and the key assessment area is the reservoir area and the D/S water reducing reach of the dam site.

(5) The assessment range of social environment: It is included the construction land occupation area of Tongxinqiao HPP, in which includes the reservoir submerging affected area, the construction area of the project, access road and power transmission lines; the resettlement areas and other potential impact objects of the project.

(6) The assessment range of geological environment: Reservoir drawdown area, the construction land occupation area, and the area affected by fluctuating water level of the river reach in Ngaw Chang Hka River.

(7) The study scope map is shown the fig.5.1-1.

(7)

Figure 5.1-1 The main sduty scope map

5.2 Assessment Method

The methods for EIA of Tongxinqiao HPP mainly include two aspects, i.e. data collection and field investigation, which are summarized as follows:

5.2.1 Data Collection

The data to be collected for the EIA of the project are as follows:

(1)First hand field investigation information, such as interview information, informal meeting information and community resource chart, as well as various video information, etc.

(2) Literatures; official statistical data, such as statistical yearbooks of different levels of government, and relevant policy-nature documents promulgated, etc..

5.2.2 Field Investigation and Environmental Quality Monitoring

(1) Flora and Vegetation investigation

The methodology involved in assessing the forest and vegetation cover was to compile maps and available literature on the land and water resources of the region and in particular the survey area. Based on these maps and literature, the field survey was conducted in February 2014 to collect primary data concerning tree and vegetation species, density and estimated volume per hectare for big tree species with diameter at breast height (DBH) of more than 4 centimeters.

The main method used in this survey is similar to that used for the wildlife survey including interviews with villagers, especially senior persons who have experience with the types of vegetation and non-timber forest products in their vicinity. The villagers were questioned on land use as well as lists of vegetation and NTFPs.

Systematic data was collected from 6 temporary sample plots (20 m x 20 m each) that were set in the form of quadrat system covering the dam sites according to land use, geographic conditions and forest types. The sample plots were set in the dominant area or good sample areas located where the dam will be located. Then, the data collected depended on their shapes and size.

Status of the plant species is then assessed according to the current IUCN classification (IUCN, 2009).

(2) Wildlife investigation

The surveys were conducted to provide baseline information on the distribution of wildlife and wildlife habitats to determine likely impacts of the project on such fauna and to assess how any such impacts might be mitigated through appropriate interventions.

After a review of available literature, a field survey was conducted in cool-dry (February 2014) season to collect primary field data concerning all wildlife species including mammals, reptiles, amphibians and birds.

Within and around the survey areas, wildlife conditions were surveyed and assessed by visual inspection and interviews with villagers, as well as from secondary data and information gathered from available sources such as persons concerned with wildlife. Additionally, wildlife within circular sample plots for forest collection were recorded, such as the animals, foot-prints, nests, burrows, hair or feathers, molts, sounds and any other evidence.

Status of the wildlife species is then assessed according to the current IUCN classification (IUCN, 2009).

(3) Aquatic Biota investigation

1) Sampling stations

Cool dry season survey along the River segment was conducted in February 2014 at six stations: three located at upstream and three located at downstream.

Examination of aquatic fauna and flora included distribution of indigenous fish species and their abundance in particular areas of the river. Plankton and benthos, which provide nutrients to young fish, were also examined.

The aim of the survey was mainly to determine the existence of aquatic life in the river. Study results and other relevant data (hydrology, water quality) were used to predict possible changes in aquatic life after project development and its effect on peoples' livelihood.

2) Fish sampling

Fish were collected using sampling seine net with the size of 430 x 160 cm with 5 mm mesh size. At the site, the seine net was equipped with bamboo pole at each end that was at least equal to the height of the net. Haul seine was operated and fished parallel to the river bank.

Fish samples were preserved in a plastic bottle or a jar containing 10% formalin solution. The bottle was labeled with information such as date of sampling, station code, name of collector

and time of collection. The samples were sent to a laboratory for species identification. In the laboratory, fish sampled from each station were identified by using a magnifier, a dissection microscope and classification guidance books. Their productivity in the river was recorded.

3) Plankton sampling

Plankton sampled from those stations was conducted using plankton net of 70 μm mesh size and a 2-litter beaker. Sampling depth of water was taken at 30 cm below the water surface. Samples were preserved in a plastic bottle containing 5% formalin solution. Information such as the code of sampling station and date were marked on the bottle. The specimens were sent to a laboratory for species identification as well as their density.

4) Benthic sampling

Benthic fauna at each station was sampling using an Ekman dredge. The samples were sieved by using a 1 mm-mesh sieve. Each specimen was preserved in a separate bottle containing 7% formalin solution. Necessary information was labeled on the bottle. They were delivered to a laboratory for specie identification and density assessment.

(4) Water environment investigation

1) location of the sampling point

The location in details sees Table 5.2-1 and Figure 5.2-1.

Table 5.2-1 Sampling Points for Water Quality Survey

Sampling Point	Coordinates	Description of Sampling Point
NSW-8	26° 1'1.34"N , 98°25'30.56"E	Ngaw Chang Hka River, about 300 m north or upstream of proposed Hkam Kawn Dam site
NSW-9	25°55'57.08"N , 98°23'23.61"E	Hkain Shan Chaung, a tributary of Ngaw Chang Hka River, about 3.7 km south of proposed Tongxingquao Dam site
NSW-10	25°57'45.87"N , 98°22'35.32"E	Ngaw Chang Hka River, about 200 m west or downstream of proposed Tongxingquao Dam site
NSW-11	25°59'18.40"N , 98°18'2.90"E	Ngaw Chang Hka River, about 3 km south or downstream of proposed Tongxingquao Powerhouse
NSW-12	26° 0'22.61"N , 98°17'20.00"E	Nga maw Chaung, a tributary of Ngaw Chang Hka River, about 1 km south of proposed Tongxingquao Powerhouse
NSW-13	26° 1'55.40"N , 98°16'34.15"E	Ngaw Chang Hka River, about 2.5 km north downstream of proposed Tongxingquao Powerhouse

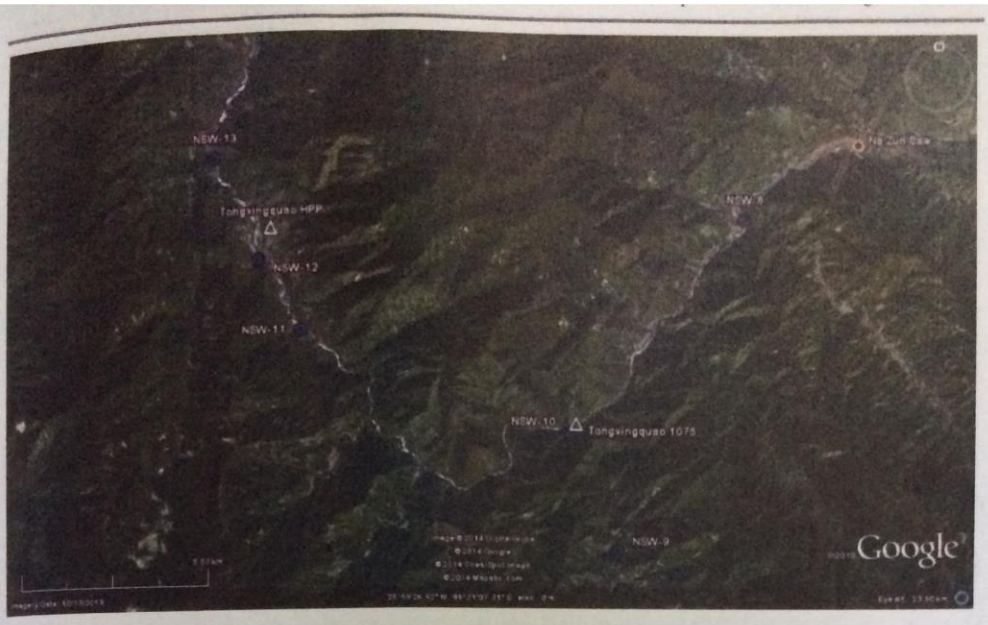


Figure 5.2-1 Location map of the sampling points

2) Survey method

Valeport digital water velocity meter and HONDEX digital depth sounder are utilized for river flow rate and water depth measurement. Water samples were taken by Alpha horizontal water sampler and collected in sterilized sample containers. All sampling was in strict accordance with recognized standard procedures. The parameters as pH, temperature, velocity, salinity, colour, odor, dissolved oxygen (DO), electrical conductivity (EC), and turbidity were measured at each site concurrently with sample collection. Tide condition were also noted. All samples were kept in iced boxes and were transported to the laboratory and stored at 2-4 °C refrigerators. The methods of every parameters is shown in Table 5.2-2.

Table 5.2-2 Test Methods for water quality

No	Item	In-situ & Lab Analysis method
1	pH	HI7609829-1 Sensor (In-situ)
2	ORP	HI7609829-1 Sensor (In-situ)
3	EC	HI7609829-1 Sensor (In-situ)
4	Dissolved oxygen	HI7609829-2 Sensor (In-situ)
5	Total Dissolved Solid	HI7609829-4 Sensor (In-situ)
6	Turbidity	HI7609829-4 Sensor (In-situ)
7	Total Hardness	AAS – Graphite Furnace Method
8	Bi-carbonate	AAS – Graphite Furnace Method
9	Biochemical oxygen	Direct inoculation method

No	Item	In-situ & Lab Analysis method
	demand(BOD_5)	
10	Chemical oxygen demand(COD)	Dichromate method
11	Suspended Solids	Gravimetric method
12	Copper	Hanna HI 83200 Multiparameter Bench Photometer
13	Ortho Phosphours	Molybdenum antimony anti-spectrophotometric method
14	Sulphate	Hanna HI 83200 Multiparameter Bench Photometer
15	Sulfide	Hanna HI 83200 Multiparameter Bench Photometer
16	Iron	AAS – Graphite Furnace Method
17	Lead	AAS – Graphite Furnace Method
18	Mercury	AAS – Graphite Furnace Method
19	Arsenic	Arsenic Test Kit
20	Coliform	AOAC Petrifilm Method

(5) Atmospheric and Acoustic Environment

1) location of air quality and noise monitoring

Noise level monitoring and air quality monitoring were conducted in each of same location. The detail of the locations are described in in Table 5.2-3 and Figure 5.2-2.

Table 5.2-3 Location of air quality monitoring station

Sampling Point	Coordinates	Description of Sampling Point
NAN-5	25° 57' 45.12" N, 98° 22' 32.73" E	Southwest of Vi lat village, south bank of Ngaw Chang Hka, about 300 m downstream of proposed Tongxingquao dam site.
NAN-6	26° 0' 29.07" N, 98° 17' 15.57" E	Just north of Nga maw soak village, west bank of Ngaw Chang Hka, about 800 m southwest of proposed Tongxingquao powerhouse.

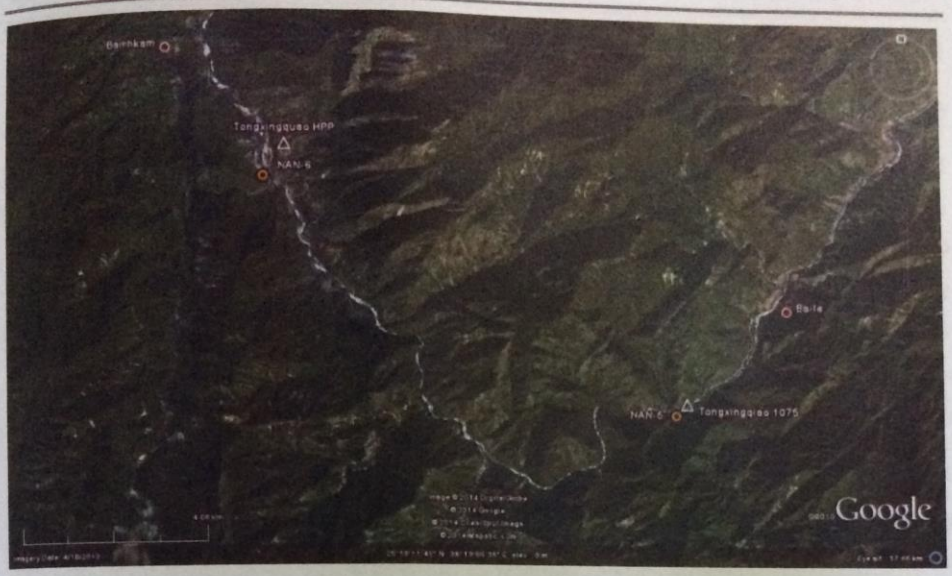


Figure 5.2-2 Location map of the air quality and noise monitoring points

2) Monitoring methods

It was conducted for 24 hours/one day during March 2014. The methods are as below.

① Air quality

Sampling and analysis of ambient air pollutants was conducted by referring to the recommendation of United States Environmental Protection Agency (U.S. EPA). The Haz-Scanner EPAS Wireless Environmental Perimeter Air Station was used to collect Ambient Air Monitoring data.

② Noise

Measurement of environmental sound level was conducted by referring to the recommendation of International Organization for Standardization (ISO), i.e. ISO 1996-1:2003 and ISO 1996-2:2007. The instrumentation used for noise quality survey is Sound level meter with SD Card, Model SL-4023SD.

5.3 Physical components

5.3.1 Topography

Ngaw Chang Hka Basin is located on northern plateau of Myanmar. Ngaw Chang Hka River is a primary tributary on L/B of Nmai Hka River, originated from the west side of Mt. Gaoligong, the full length of the mainstream is about 144.6km, which is generally U-shaped, the upper reaches flow approximately from NE to SW and then turn from north to south, while the middle reaches turn from east to west and then turn from NE to SW, and the lower reaches generally flow from south to north, and eventually flows into Nmai Hka River. It is the largest tributary flowing into the middle reaches of Nmai Hka River.

The project area is located D/S of Ngaw Chang Hka River. The terrain in the territory is generally higher in the east and lower in the west, the elevations of the peaks in the central and eastern parts are mostly above 3,000m, the elevation of the highest Peak is El. 4,075m. The regional geomorphic feature are mainly manifested as middle and alpine erosion landform, and the main mountain ranges and rivers are subject to control of structures of NNE direction. Gullies are developed on both banks of the river channel, with rather poor topographic integrity. The river channel has great gradient and narrow river surface, and only part of the river reaches are developed with alluvial-diluvial terrace.

5.3.2 Geomorphy

Mountains on both banks of the reservoir area are thick, the main bedrock is granite, with relatively weak water permeability and water yield property. The L/B of the reservoir area is mainly debris flow accumulation terrace bank slope, locally being steep hill slope, and the terrace bank slopes are generally stable for the time being; the R/B is mainly mountain front slope, the terrain of bank slope is generally gentle, with well developed vegetations, and the bank slopes are naturally stable. The distribution elevations of underground water level divide (watershed) on both banks of the reservoir area are higher than the FSL of the reservoir, without the issue of seeping toward the low adjacent valleys.

5.3.3 Geology

5.3.3.1 Basic Geological Condition

At the feasibility study stage of Tongxinqiao HPP, KHIDI successively finished 1:1,000 engineering geologic surveying and mapping of the dam site area and the powerhouse site

area, and conducted corresponding explorations and tests. Simultaneously, KHIDI reviewed regional geology and 1:10,000 comprehensive geologic investigation of the reservoir area, conducted a lot of geological surveying and mapping, generally and preliminarily investigated the natural building materials, finished geologic investigations about 128km^2 of collapses, landslides and debris flows, accumulatively about 3,000m/39 boreholes and adits, more than 180 times of water pressure test and penetration tests, 387m/strip of seismic exploration of the dam site, and 2,690m/6 pieces of seismic exploration of powerhouse. According to comprehensive analysis and judgment of geologic work finished, we may learn that:

① The project area is located at the west edge of Boshula Ridge — Mt. Gaoligong fold system, a secondary structure of Gangdisi — Nianqingtanggula Geosynclinal fold system, in Southwest Yunnan seismic belt, at the Northwest end of Manji – Tengchong – Longling seismic belt. There are very strong neo-tectonic movements in the region, the advantageous direction of the principal compressive stress of regional modern structural stress and NNE ~ NE, with horizontal actions being dominant.

② The reservoir area of the HPP has medium-high mountain and deeply cut corroded and eroded canyon landform, the canyon section is slightly asymmetric V-shape, the outcropped strata lithology is medium-coarse grained granite of Yanshanian period (γ_{53}), which are hard rocks; geologic structure in the reservoir area is undeveloped, without development of such unfavorable physical-geologic phenomenon, such as relatively large landslide, and the physical-geological phenomena in the reservoir area are mainly manifested as weathering and unloading, etc. To be specific, there is only a collapse accumulation mass (B_3) developed at the reservoir section near the dam, but its scale is not large, and it is in the long-term stable state.

Both banks near the FSL of the reservoir are mostly bedrock bank slopes, the thickness of the distributed Quaternary overburden is relatively small, the reservoir banks are basically rocky ones, with good ~ relatively good stability; there are underground and ground watersheds far higher than FSL of the reservoir on both banks of the reservoir area, without low adjacent valley on both banks, there is not permeable earth-rock stratum or relatively large permeable fault distributed, the closure conditions of the reservoir basin are generally good, and the possibility of seeping toward the D/S river channel is low; the sources of solid runoffs in the reservoir area are relatively few, without mineral immersion or reservoir submerging issue; it does not have such conditions as strata lithology for generaring reservoir-induced earthquakes,

and the possibility of generaring reservoir-induced earthquake is low. The conditions for building reservoir of the HPP are relatively good.

③ The river channel of the dam site is smooth and straight, the weathering of rock masses on both banks is generally not deep, the river side is mostly exposed with bedrocks, and mostly being weakly weathered rock masses; the overburden on both banks of the dam site is relatively thin, the thickness of the riverbed alluvium is about 10m~14m, and the rock masses are relatively complete. The lithology of bedrocks outcropped in the dam site area is medium-coarse grained granite of Yanshanian period (γ_{53}), which are hard rocks with high rock strength. The rock mass integrity of foundation plane is good, only part of the structural development parts are relatively fractured, and there is no moderate or gentle dip angle fault developed at the dam foundation. Rock masses of the dam foundation are mostly Class II. The slope excavation quantity on both banks of the dam are generally not large, without large structural plane or assembly with unfavorable structural plane - controlled slope stability, and the overall stability of slope is relatively good.

Most sections of the headrace tunnel are deeply embedded tunnels, the surrounding rocks are mostly weakly weathered ~ fresh rock masses, mostly being relatively complete, and mainly being Classes II and III. The overall surrounding rock stability conditions are relatively good, only the surrounding rocks at the tunnel section outcropped with faults are mainly Class V, with poor stability conditions.

The powerhouse site of the HPP is located on Grade I terrace on R/B of Ngaw Chang Hka River, the terrace is developed with a relatively large multi-cause accumulation mass, which is topographically rugged, but the gradient is generally gentle, and the natural hill slope is stable. After the powerhouse foundation is excavated up to the elevation of the foundation plane, the rock masses of the foundation plane are mainly slightly weathered rock masses, locally with weakly weathered rock masses. The rock masses are mostly relatively complete ~ complete, with poor integrity in the local area, the rock quality is hard, the foundation bearing capacity is mostly high and with good stability, rock mass quality is mostly Class II, locally being Classes III1~III2. The highest slope after excavation of the powerhouse is about 73m, mainly being weakly weathered rock masses under El. 806m; while above El. 806m are mainly multi-cause accumulation masses and a little fully ~ strongly weathered rock masses of the lower part, which are structurally loose or relatively fractured, with relatively abundant pore water in the slope media. The geological map around the project is seen

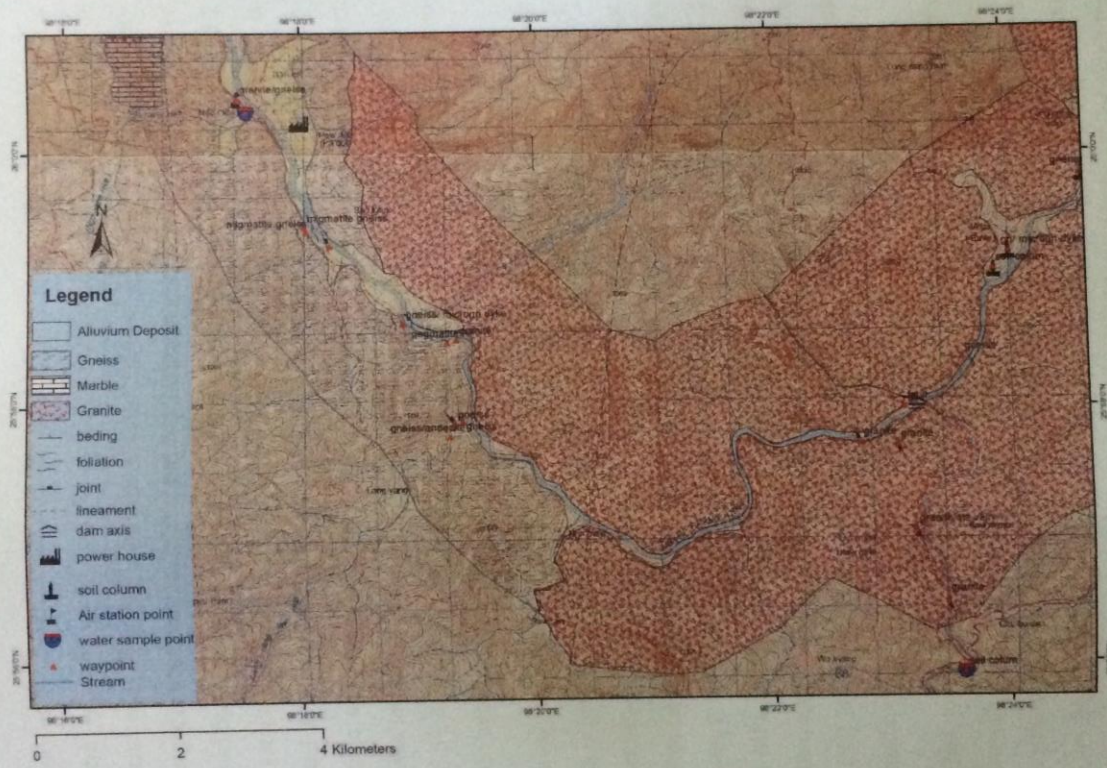


Figure 5.3-1 Geological map of around the Tongxingqiao Dam and Power House

5.3.3.2 Physical Mechanical Properties of Rocks and Soil

(1)Physical-Mechanical Properties of Rock

Four physical-mechanical properties tests of the rock of the core sample in the drill-hole of the drill-hole are finished at the feasibility study stage, and see Table 5.3-1 for the test outcome.

The specific gravity of the weakly weathered and fresh medium coarse-grained granite rock is between 2.67 g/cm^3 and 2.69 g/cm^3, and the average value is 2.68 g/cm^3; the dry density is between 2.63 g/cm^3 and 2.65 g/cm^3, and the average value is 2.64 g/cm^3; The uniaxial dry compressive strength is between 126.2 MPa and 145.1 MPa, and the average dry compressive strength is 135.9 MPa; the uniaxial wet compressive strength is between 110.9 MPa and 136.2 MPa, and the average wet compressive strength is 126.8 MPa; the softening coefficient is between 0.92 and 0.94, and the average softening coefficient is 0.93; the uniaxial dry compression elastic modulus is 27.5 GPa, and the Poisson ratio is 0.22; the uniaxial wet compression elastic modulus is 35.9 GPa, and the Poisson ratio is 0.29; the dry shear strength (Φ) equals to 46.5°, and C equals to 14.7 Mpa; the acoustic wave (Vs) is between 4.60 and 5.44 km/s, and the average is 5.425 km/s. The rock belongs to the hard rock.

The specific gravity of the weakly weathered and slightly weathered, and fresh stria shaped chorismite rocks is between 2.69 g/cm^3 and 2.70 g/cm^3, and the average value is 2.70 g/cm^3; the dry density is between 2.59 g/cm^3 and 2.63 g/cm^3, and the average value is 2.61g/cm^3; the uniaxial dry compressive strength is between 98.1 MPa and 122.4 MPa, and the average dry compressive strength is 111.6 MPa; the uniaxial wet compressive strength is between 51.5 MPa and 119.5 MPa, and the average wet compressive strength is 84.1 MPa; the softening coefficient is between 0.45 and 0.79, and the average softening coefficient is 0.62; the acoustic wave (Vs) is between 3.13 and 5.32 km/s, and the average is 4.92 km/s. The rock belongs to the hard rock.

According to the test results, the following analysis can be performed, namely: the compressive strength of the stria shaped chorismite in the project area is controlled by the relatively weak structural plane (gneissosity), and the gneissosity inclination angle is between 75° and 85°, the pressurization direction of the rock sample of the drill-hole and the gneissosity form an included angle of 5° and 15°, so the collapse is mainly caused along the gneissosity, the strength value in the test results is relatively low.

Table 5.3-1 Summary Table of the Physical-Mechanical Test Outcome of the Rock

Project Place	Rock Sample Number	Sampling Depth (m)	Rock Sample Designation	Rock Stratum Code Number	Rate of erosion	Quantity of the test group	Physical Test					Mechanical Test											Acoustic Wave (km/s)
												Compressive strength			Uniaxial compressive deformation test				Shear strength			
															Dry		Wet		Dry			
							Specific gravity	Dry density	void ratio	natural absorption ratio	saturated absorption ratio	dry compressive strength	Wet compressive strength	Coefficient of softing η	Elastic modulus $E_{50}*10^4$ (MPa)	Poisson ratio μ_{50}	Elastic modulus $E_{50}*10^4$ (MPa)	Poisson ratio μ_{50}	Internal friction angle φ (°)	Cohesive strength (MPa)		
								(g/cm^3)	(%)			(MPa) Dry compressive strength (MPa)											
Right Bank of the Upper Damsite	ZH102-1	30.38～31.87	Light grey medium coarse-grained granite	γ_5^3	Slightly new		2.67	2.65	0.75	0.22	0.23	139.0 145.1 128.1	133.1 136.2 119.7	0.94	2.75	0.22	3.59	0.29	46.5	14.7		4.60
In the River of the Upper Damsite	ZH101-1	16.48～17.81	Light grey medium coarse-grained granite	γ_5^3	Slightly new		2.69	2.63	2.23	0.12	0.14	138.0 126.2 139.0	134.8 110.9 126.0	0.92								5.44
Average							2.68	2.64	1.49	0.17	0.19	135.9	126.8	0.93								
Surge shaft	ZH110-1	56.40～58.30	Light grey yellow stria shaped chorismite	Pt_2	Weak		2.69	2.59	3.72	0.66	0.67	98.1 122.4 119.5	51.5 72.4 119.5	0.45								
Surge shaft	ZH110-2	132.59～134.10	Light grey stria shaped chorismite	Pt_2	Slightly new		2.70	2.63	2.59	0.29	0.31	115.3 100.2 114.0	87.7 88.1 85.1	0.79								
Average													2.70	2.61	3.16	0.48	0.49	111.6	84.1	0.62		

It was completed enough field explorations in the surrounding area. The workload is shown in the table 5.3-2. Some drill hole geological log example is shown in the Figure 5.3-2, Figure 5.3-3.

Table 5.3-2 exloration workload table

Drill hole	Dam site	m/ piece	147.31/3
	Powerhouse area	m/ piece	274.83/4
	Other	m/ piece	0/5
Adit	Dam site	m/ piece	0/2
Exploration pit and exploration trench		m^3	190.6/997.7

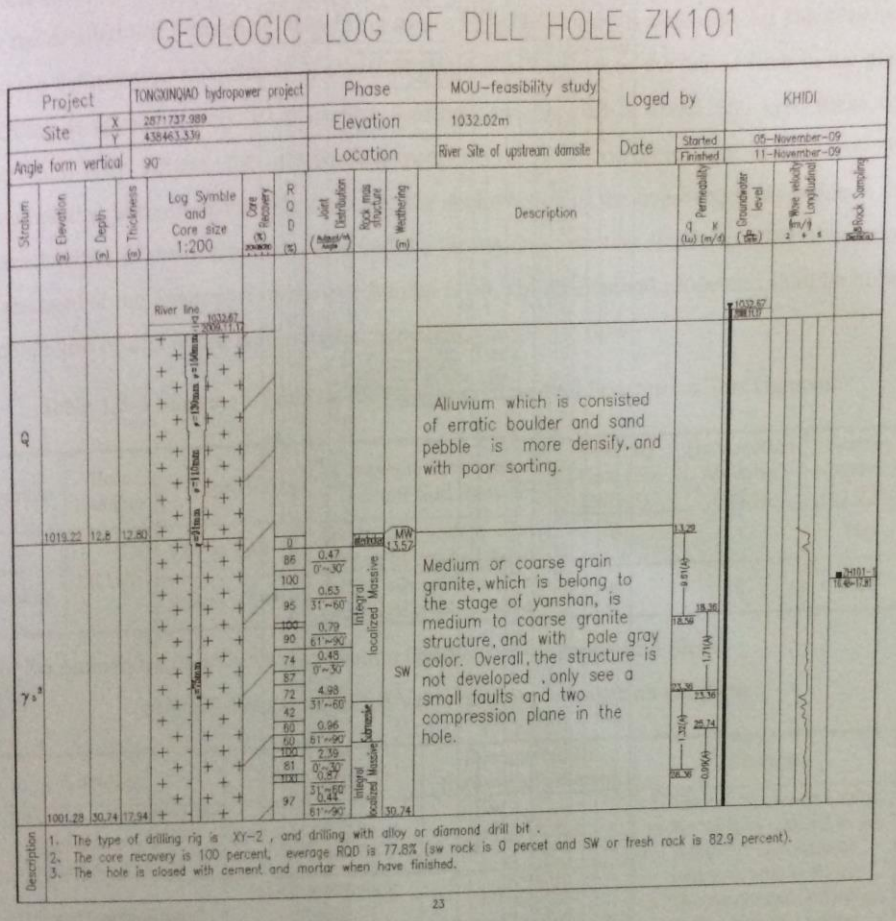


Figure 5.3-2 Drill hole ZK101 geological log

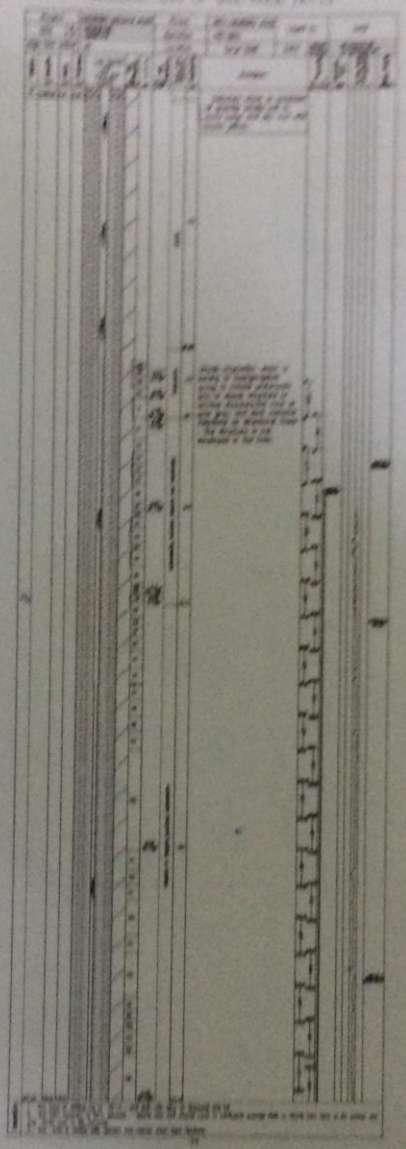


Figure 5.3-3 Drill hole ZK110 geological log

(2) Recommended data of the Structural Mechanics Parameters of the Overburden Layer

Both in-situ standard penetration tests are performed only to the accumulation horizon of the debris flow in the overburden layer of the project area of the plant building, see Table 5.3-2 for the detailed test outcomes. According to the statistical analysis outcome, we can conclude that the deformation modulus (E0) of the accumulation horizon of the debris flow in the plant building is approximately 10 Mpa, the bearing capacity (fk) is about 180 kpa, these test outcomes only reflect the mechanical property of the corresponding horizon of the accumulation horizon of the debris flow at the shallow part of the overburden layer due to the characteristics of the overburden layer and the limitation of the test conditions. The alleviation is arranged at the lower part of the overburden layer, the mechanical properties shall be better than the test results of the accumulation horizon of the debris flow.

Table 5.3-3 Summary Table on the Stone Soil Standard Penetration Test Outcome

Location	Hole Number	Depth (m)	Composite Substance of Stone Soil Body	Shocking Time (N) (N63.5)	Deformation Modulus (MPa)	Bearing Capacity (f_k) (kPa)
Plant Building	ZK116	1.94 to 2.39	Sandy silt with a small amount of crushed stone	5	7	180
		3.94 to 4.39	Sandy silt with a small amount of crushed stone	5	7	180

(3) Recommended data for the Excavation Gradient of the Stone Soil Slope

Table 5.3-4 Recommended Value of Slope Excavation Gradient

Lithology	Rate of Erosion	Recommended Excavation Gradient	Remarks
Colluvium and Drift Bed Substances in the Quaternary System	Loose	1:1.2～1:1.4	1. The recommended value in the table is applied to the slope the elevation of which is within 10 m; 2. The recommended value in the table can not be applied to the slope controlled by the structural plane.
Medium Coarse-grained Granite, Stria Shaped Chorismite	Whole and strong erosion	1:0.75～1:1	
	Weakly erosion	1:0.5～1:0.75	
	Slightly erosion and fresh	1:0.3～1:0.5	

5.3.3.3 Classification of Rock Quality

Bedrock Quality Classification of the Dam see table 5.3-4.

Table 5.3-5 Preliminary Rock Mass Quality Classification Criteria of the Dam Foundation and Recommended Mechanical Parameters

Category of the Rock Quality	Rock Name	Rock Mass Features	Engineering Geology Evaluation of Rock Mass	Rate of Erosion	Natural Density	Rrock Quality Designation (RQD)	Longitudinal Wave Velocity of Rock Mass	Moisture Compressive Strength of Rocks	Deformation Modulus (E_0)	Poisson's ratio μ	Anti-shear Strength of the Concrete / Bedrock		Shearing Resisting Strength of the Rock Mass		Bearing Capacity
					(kN/m^3)	(%)	(m/s)	(MPa)	(GPa)		f'	c'	f'	c'	f_k(MPa)
II_A	Medium Coarse -grained Granite	The rock mass presents the sub-block and block-like structure, the structural plane is developed moderately, which generally can develop two and three groups of joints, the weak structural plane is distributed rarely, or there is no the wedge body or prim which may impact on the stability of the dam foundation or dam abutment.	The rock mass is complete, the strength is high, the stability of the rock mass is not controlled by the weak structural plane, the anti-sliding and anti-deformation properties are high, the work amount specially for processing the foundation is not large, which belongs to the good and high concrete dam foundation.	Slightly fresh	26.0 ~ 27.0	>70	>4,500	>80	10.0 ~ 20.0	0.23	1.15 ~ 1.30	1.10~ 1.30	1.20 ~ 1.35	1.20 ~ 1.50	6.0 ~ 8.0
III_A III_{1A}		sub-block structure, the structural plane is developed moderately, which generally can develop two and three groups of joints, the weak structural plane with the low-angle dip or dip angle (dam abutment) is distributed in the rock mass, or there is no the wedge body or prim which may impact on the stability of the dam foundation or dam abutment.	The rock mass is complete, the partial integrity is poor, the strength is high, and the anti-sliding and anti-deformation properties are controlled by the structural plane at the certain degree. The structural plane impact on the deformation and stability of the rock mass shall be processed specially.	Weak ~ slightly	25.5~ 26.0	50 ~ 70	3,500 ~ 4,500	60 ~ 80	6.0 ~ 10.0	0.25	1.00 ~ 1.15	0.85 ~ 1.05	1.00~ 1.20	1.00 ~ 1.20	4.0 ~ 6.0

Category of the Rock Quality	Rock Name	Rock Mass Features	Engineering Geology Evaluation of Rock Mass	Rate of Erosion	Natural Density	Rrock Quality Designation (RQD)	Longitudinal Wave Velocity of Rock Mass	Moisture Compressive Strength of Rocks	Deformation Modulus (E_0)	Poisson's ratio μ	Anti-shear Strength of the Concrete / Bedrock		Shearing Resisting Strength of the Rock Mass		Bearing Capacity
					(kN/m³)	(%)	(m/s)	(MPa)	(GPa)		f'	c'	f'	c'	f_k(MPa)
III_{2A}		block-cracked structure and mosaic structure, the structural plane develops, but the structural plane with the permeability is few, the extensibility is poor, the structural plane is mainly closed, and the gomphosis ability between rock blocks is good.	The integrity of the rock mass is poor, the strength is still high, the anti-sliding and anti-deformation properties are controlled by the gomphosis ability between rock blocks and the shear strength characteristics of the structural plane, and the structural plane shall be processed specially.	weak	22.0~25.5	20~50	2,000~3,500	40~60	4.0~6.0	0.28	0.80~1.00	0.60~0.85	0.85~1.00	0.70~0.95	2.0~4.0
IV_A		The rock mass presents the cataclastic structure, the structural plane is developed well, which is mainly open to clamp the talus or mud, and the gomphosis ability between rock blocks is weak.	The rock mass is fractural, the anti-sliding and anti-deformation properties are poor, which is not suitable for the dam foundation of the high concrete dam. When the rock mass exists in the local area, which shall be processed specially.	Strong - weak	19.0~22.0	<20	<2,000	20~40	1.0~3.0	0.30	0.60~0.80	0.10~0.30	0.70~0.90	0.10~0.30	1.0~2.0
V_A		The rock mass present granular structure, and is composed of the rock block and mud or the mud and rock block, which has the loose continuous medium features.	The rock mass is fractural, so the rock mass is not suitable for taking as the high concrete dam foundation. When the rock mass is distributed at the partial section of the dam foundation, which shall be processed specially.	All-strong	17.0~19.0	0									

5.3.4 Earthquake

Earthquake Hazard is the considerable natural condition in planning the hydropower project. Since the groundshaking and surface rupture associated with earthquakes may not only induce instability of the dam and facilities, but also produce landslides along the reservoir area to increase the normal water level of dammed river that would cause serious flash flood and other damages for lives and properties of the people.

In this project, we collected seismic safety assessment report and relevant study data of the site and the surrounding areas, purchased 4-scene ETM satellite images and carried out treatment and imaging; we conducted investigation about Pailai fault, Guoyang fault, Pianma fault and Lanjian Fault and Quaternary strata and terrain involved near the site area, and collected several thermoluminescence dating samples and OSL dating samples. According to analysis about the regional fault activity and different grades of seismic structure marks, it is believed that there are the following over Mag. 6 earthquake structure in the region: Zhongdian – Longpan – Qiaohou fault belt, Qiaohou fault belt, Sagaing fault belt and Longling – Ruili fault belt are strongly active faults of Holocene epoch, such earthquake structures mostly constitute the border of active blocks, with strong activities since Epipleistocene, its horizontal displacement rate is over 3.0mm/a, the highest one is as high as 20mm/a, with the structural conditions for generating Mag. 7 and higher earthquakes; Tengchong Fault Zone, Dayingjiang Fault Zone, Longchuan River Fault Zone, and Wadelong Fault Zone are mostly distributed inside the block, the activity rate since Late Pleistocene epoch has reached 1~2mm/a, with a few being 2.5~3.5mm/a, the activity is relatively strong, which have the structural conditions for generating about Mag. 6.5 earthquakes, according to comparison of seismic structure marks.

In combination with the historic earthquake data of the surrounding area, and through comprehensive probability analysis about the seismic hazard, we obtained the seismic dynamic parameter of the bedrocks of different transcendental probability levels of the site in certain years, based on which we determined the seismic dynamic parameters of the site, as shown in Table5.3-6.

Table 5.3-6 Suggested values of seismic dynamic parameters of bedrocks

values	Probability more than 50 years		Probability more than 100 yearw
	10%	5%	2%
A_{max} (gal)	180	219	311
β	2.25	2.25	2.25
T_g (sec)	0.30	0.30	0.35
a_h(g)	0.18	0.22	0.32

The faults developed near the site of Tongxinqiao HPP, including 7 faults, i.e., Chibwe – Bhamo Fault, Sawlaw Fault, Lanjian Fault, Guoyang Fault, Pianma Fault, Pailai Fault and Lanjiao Fault, in which Pianma Fault and Pailai Fault are active ones of Late Pleistocene epoch, with the geological structure conditions for generating Mag. 6.5 strong earthquakes, while other faults are late – middle Pleistocene active ones, with relatively small sizes, and without the structural conditions for generating strong earthquakes over Mag. 6.

According to active fault study that extracted from Tectonic Map of Myanmar (2007) (Figure5.3-2), there are also the following fault systems, which maybe threaten to the Tongxingqiao Project.[①]

① after Tectonic Map of Myanmar, 2007

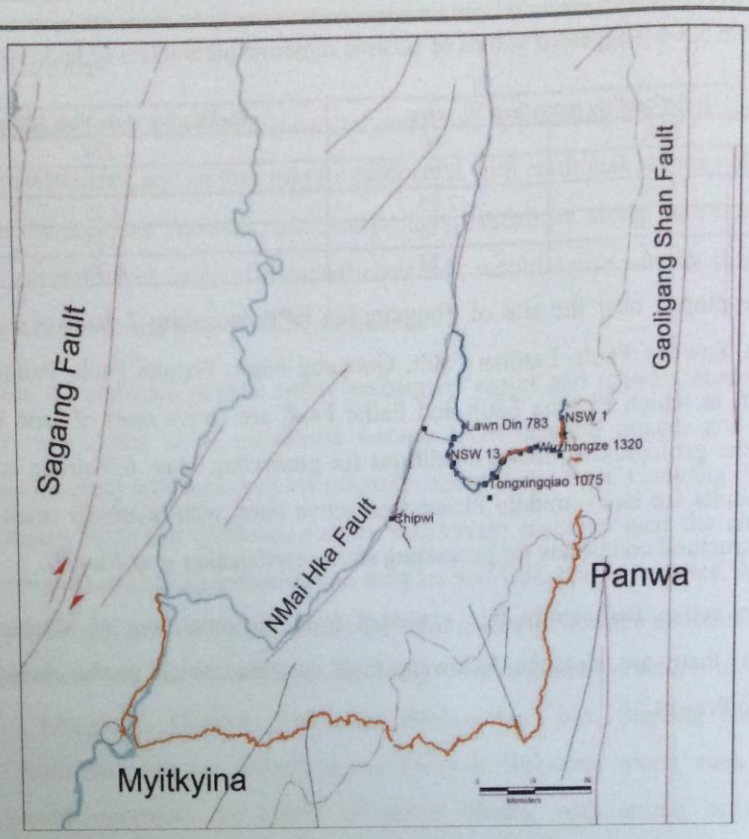


Figure 5.3-4 Active Fault Systems around the Project Location

Sagaing Fault System (100 km West of the Project Location)

N'Mai Hka Fault System (40 km West of the Project Location)

Gawligan Shan Fault system (25 km East of the Project Location)

The details of the three faults is as below.

Figure5.3-3 depicts the seismicity of the project area in which the focal depth of <40 km represents the shallow focus events, 40 – 80 km the intermediate focus and > 80 km the deep focus events, and most of the earthquakes happened in and around the project area are shallow focus earthquakes. Figure5.3-4 shows the previous earthquakes that are the magnitude greater than 6.0 (Mw) while Figure5.3-5 illustrates the occurrences of the magnitude ≥ 6.5 eartqhaukes. Most of the shallow earthquakes are resulted from the right-lateral strike-slip Sagaing Fault, the relative movement of which is 18 mm/yr, and is 100 km far to the west. The magnitudes are mostly greater than 7.0 Mw. For examples are Aug. 31, 1906 (7.0); Dec. 12, 1908 (7.5); and Jan. 27, 1931 (7.3) earthquakes. There are no records of damages and

casualties for these earthquakes. Even though the earthquakes happened at the place very closed to the project in Jan. 19 and Dec. 16, 1929, there is no records about the magnitude. However, the two magnitude 6.5 earthquakes (Aug. 11, 1933 and March 22, 1955) struck in the north and south of the project area at about 50 km away. It is there clearly seen that the project area is medium to high seismicity area.

Soe Thura Tun et al. (2011) developed the active faults database for Myanmar for the seismic hazard assessment. They estimated the seismic source parameters of the active faults such as Sagaing Fault, Kyaukkyan Fault, Nampon Fault, Moemeik Fault, Shweli Fault, Three Pagodas Fault, Pa-Pun Fault, West Bago Yoma Fault, Gwegyo Thrust, etc. by using the prevsious historical event, paleoseismological study, fault slip rate, the fault rupture length of each segment, and other geological data. Myo Thant et al. (2012) conducted the probabilistic seismic hazard assessment for Myanmar as the whole country. In their case, they also developed the seismic source database for areal seismic sources, especially for the subduction zone of Indian Plate beneath Myanmar Plate in the west of Myanmar, the collision zone of Indian Plate and Eurasia Plate in the north-west, and four areal seismic sources in eastern highland (Shan Plateau region) where the seismic source parameters of the active faults are not well-known, i.e. the detailed information such as the slip rate, the relationship of the previous earthquakes and the certain active faults are not available.

By combining the active faults database of Soe Thura Tun et al. (2011), Myo Thant et al. (2012) developed the probabilistic seismic hazard maps of Myanmar by means of peak ground acceleration (PGA); spectral acceleration (SA) at the natural periods of 0.2 s and 1.0 s; and peak ground velocity (PGV) for 10% and 2% probability of exceedances in 50 years (it means 475 years and 2,475 years recurrence interval).

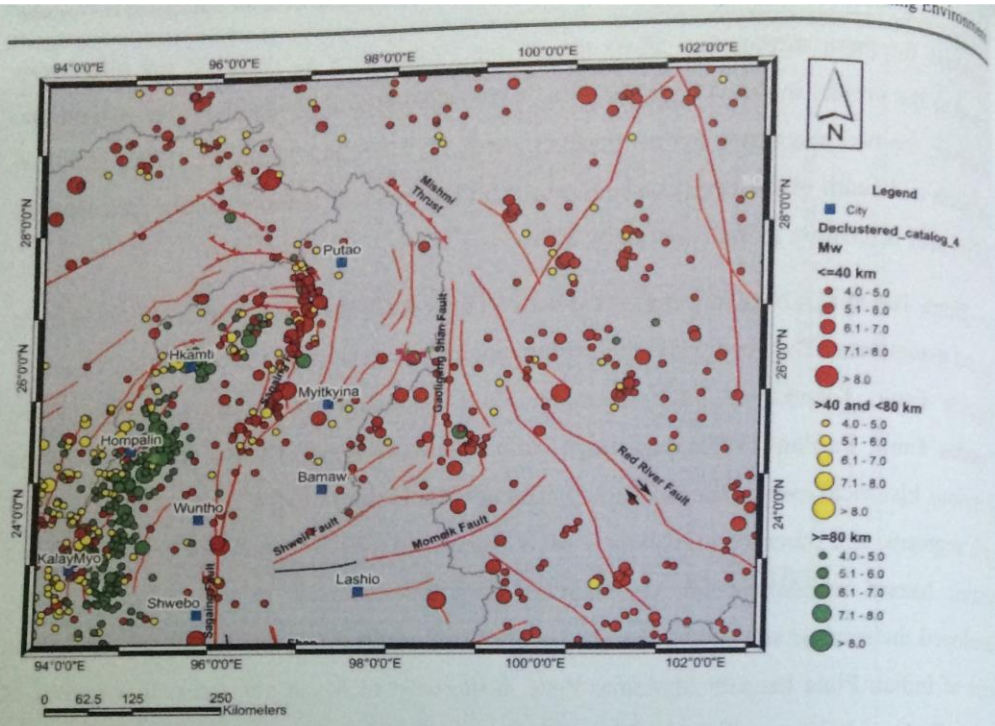


Figure 5.3-5 Seismicity map of the project area

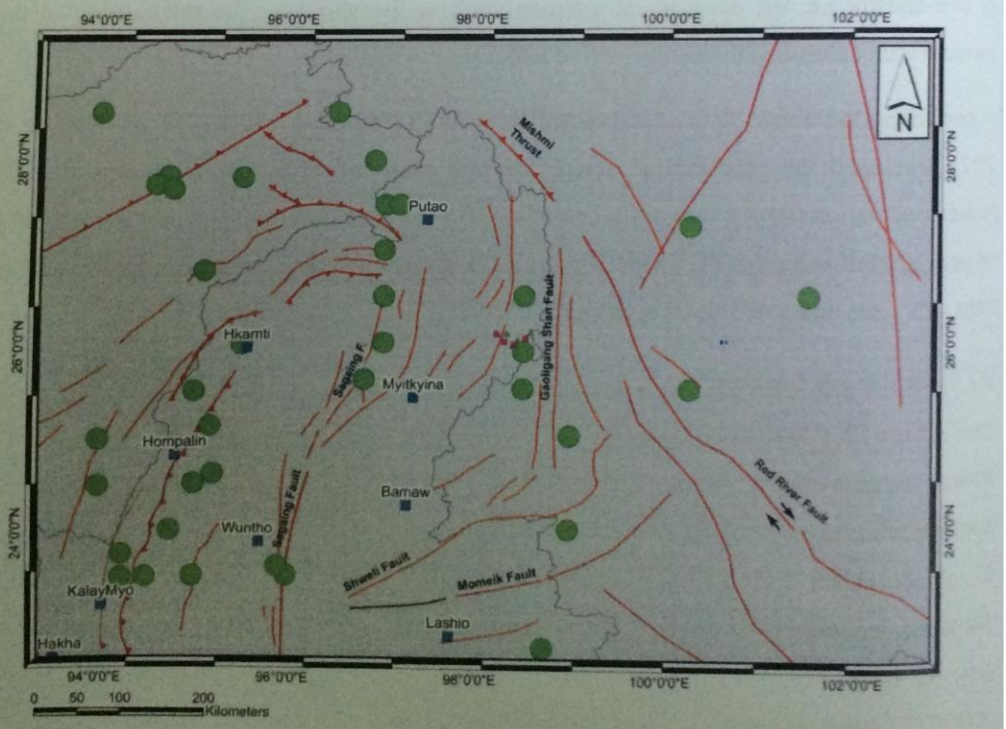


Figure 5.3-6 Significant events happened in and around the project area

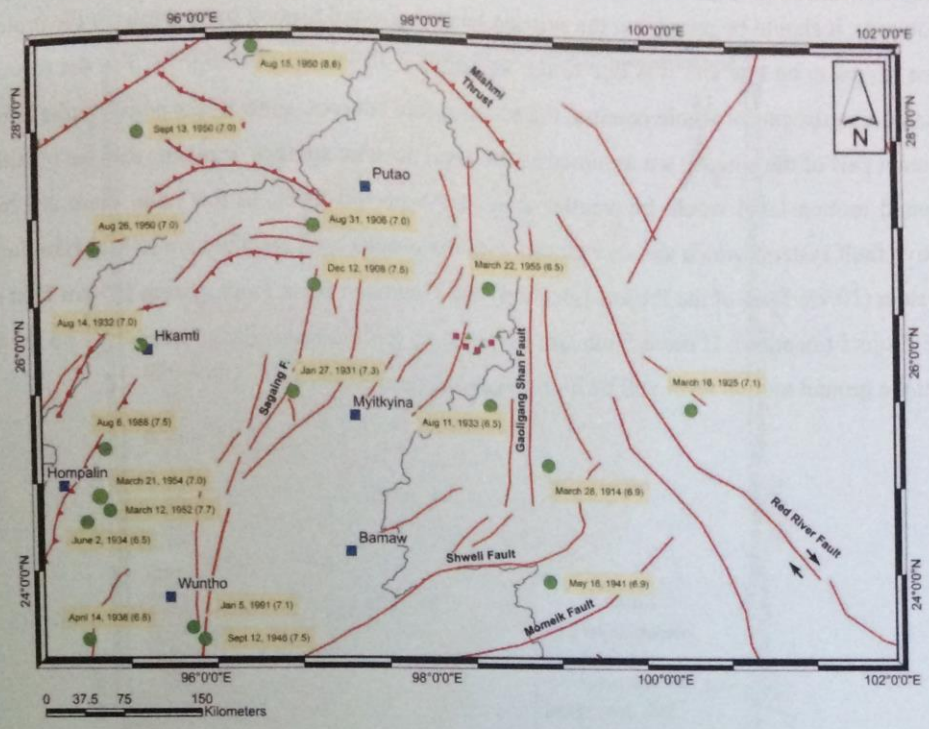


Figure 5.3-7 Active faults map of the project area with the previous earthquakes (the magnitude $\geqslant$ 6.5)

In sum, as mentioned in the previous sessions, the probabilistic seismic hazard maps are developed for Myanmar as the whole country by Myo Thant et al. (2012) under Myanmar Earthquake Committee (MEC). Moreover, they also developed the seismic hazard maps for region level. The seismic hazard maps of Kachin State are shown in Figure5.3-6 and Figure5.3-7 for 10% and 2% probability of exceedance in 50 years. The peak ground acceleration (PGA) for 475 recurrence interval ranges from < 0.1 g to 1.7 g as a whole. In this case, the project area is in the range of 0.1 g to 0.2 g for PGA. With regards to the seismic hazard estimation for 2,475 years recurrence interval, PGA values for Kachin State are < 0.1 g as the minimum and 1.2 g as the maximum ones. However, the PGA value of the project area belongs to 0.2 g to > 0.4 g for this recurrence interval. As the region level, the highest seismic hazard zones correspond to the most active right-lateral strike-slip Sagaing Fault.

Generally, PGA values for 475 years recurrence interval are used as the seismic hazard as the operation basic earthquake (OBE) level while those for 2,475 years recurrence one are for maximum credible earthquake (MCE) level.

However, it should be noted that the seismic hazard, ground motion parameters for the project area seems to be low and it is due to the assumption of the seismic sources. For the seismic hazard assessment for whole country, the seismogenic sources, some of the active faults in the eastern part of the country are assumed as the areal seismic sources. It means that the resulted ground motion level would be smaller than that expected level. In this case, there are two active fault systems which are very closed with the project area and they are N'Mai Hka Fault System (10 km West of the Project Location) and Gawligan Shan Fault system (55 km East of the Project Location). If these faults are assumed as the fault specific sources, it is no doubt that the ground motion level will be higher than the present PGA level.

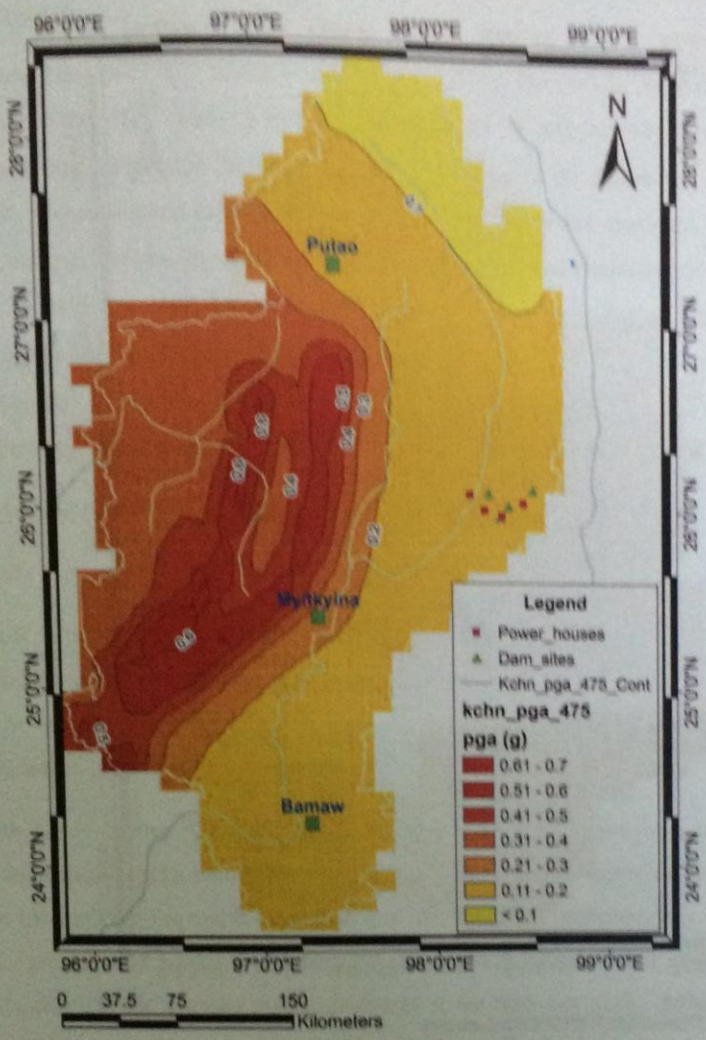


Figure 5.3-8 Probabilistic Peak Ground Acceleration Map of Kachin State for 10% probability of exceedance in 50 years

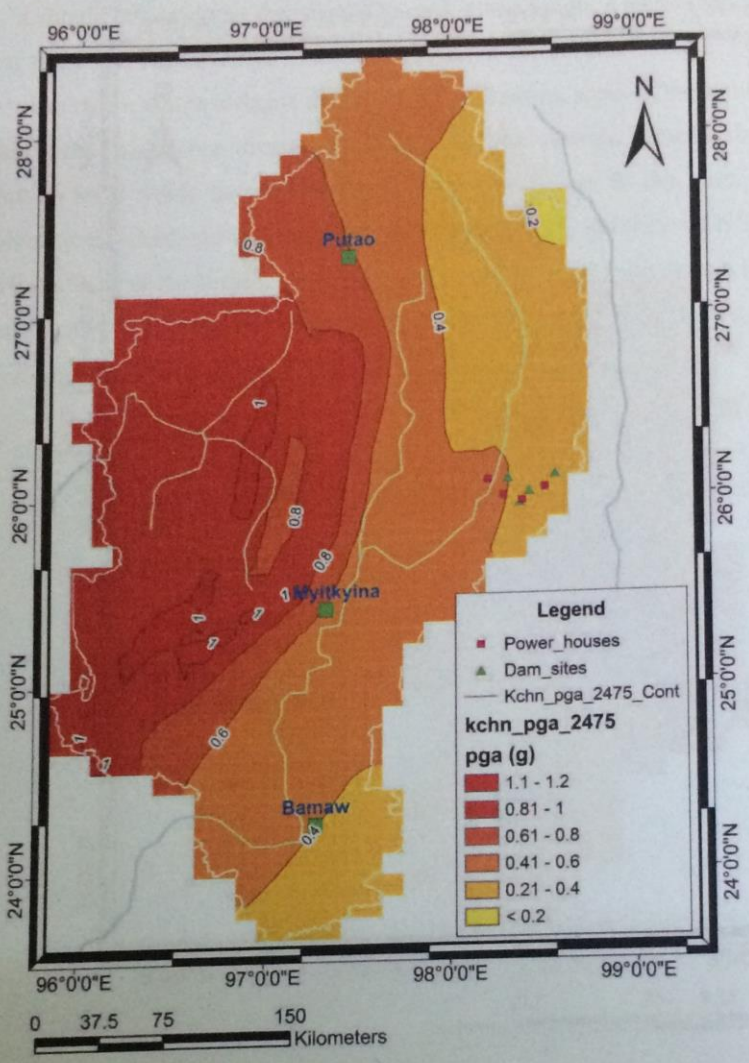


Figure 5.3-9 Probabilistic Peak Ground Acceleration Map of Kachin State for 2% probability of exceedance in 50 years

In sum, through comprehensive probability analysis about the seismic hazard, the peak ground acceleration of bedrock at 10% probability of exceedance in 50 years in the dam site of this project is 0.18g, while that of ground at 10% probability of exceedance in 50 years in the powerhouse site of this project is 0.21g, and basic seismic intensity of the site is Mag. VIII, which is a high seismic intensity area.

5.3.5 Climate

Ngaw Chang Hka River is a primary tributary on L/B in the middle reaches of Nmai Hka River, while Nmai Hka Basin is in the upper reaches of Ayeyarwady River, which has subtropical climate with high humidity and a lot of rain, and the distinctive dry season and wet season. Meteorological data of Ngaw Chang Hka Basin is not available, it is to refer to Lushui (Luzhang) Meteorological Station for the meteorological characteristics in the project area of Tongxinqiao HPP. According to statistics of meteorological data of Lushui Meteorological Station, the perennial average air temperature is 15.2℃, the perennial average precipitation is 1,225.6mm, the perennial average evaporation is 1,624.9mm, and the perennial average wind speed is 2.1m/s.

5.3.6 Hydrology

(1) Runoff

The runoff at the Ngaw Chang Hka River Basin is mainly constituted by the precipitation, with a small amount of melted snow. Geographically, the project site lies in the north rainy area of Myanmar, where the runoff is basically consistent with the precipitation in annual variation, which is uneven.

Since the Ngaw Chang Hka River Basin is long and narrow, covering wide latitude, the precipitation distributions within the basin differ greatly and the main streams are different from the tributaries in the runoff characteristics. The modified precipitation is more consistent with the precipitation runoff characteristics of the basin. After overall consideration, it is recommended that the average annual discharge at the dam site of the Tongxinqiao HPP is 124m^3/s. The measured hydrograph of the Ngaw Chang Hka River Hydrometrical Station (in Myanmar) is applied to monthly runoff distribution mode of 1959 ~ 2010. The results of the annual average monthly discharge at the dam site of the Tongxinqiao HPP are shown in Table 5.3-7.

Table 5.3-7 Annual Average Monthly flow at the Dam Site

month	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	anual
Flow(m^3/s)	49.0	44.7	44.2	43.9	74.7	209	339	275	203	167	99.0	65.0	135

(2) Flood

For the lack of actually measured flood and rainstorm data about the Ngaw Chang Hka River Basin and the Ngaw Chang Hka River Hydrometrical Station can only provide the available

flood data in 2009 and 2010, it is impossible to directly reckon the flood of the Tongxinqiao HPP with these data. The results values obtained with the area analogy method (the Zhanxi Hydrometric Station) shall be adopted as the design flood values at the dam site of the Tongxinqiao HPP. Refer to Table 5.3-8 for the results of design flood at the dam site.

Table 5.3-8 Results of Design Flood at Dam Site

location	Frequency (%)								
	0.1	0.2	0.33	0.5	1	2	3.33	5	10
Damsite	3090	2850	2670	2530	2300	2060	1880	1740	1500
powerhouse	3310	3060	2860	2710	2460	2210	2020	1870	1600

5.3.7 Soil and Sediment

(1) soil

The regional altitude difference in the Republic of the Union of Myanmar is great and the relative height difference is more than 1,000 m. With the variation of the altitude, the soil is distributed in bands and spectrums along the altitude. There are 18 soil types based on the altitude and the physicochemical property of soil. Refer to figure 5.3-10 for the specific distribution.

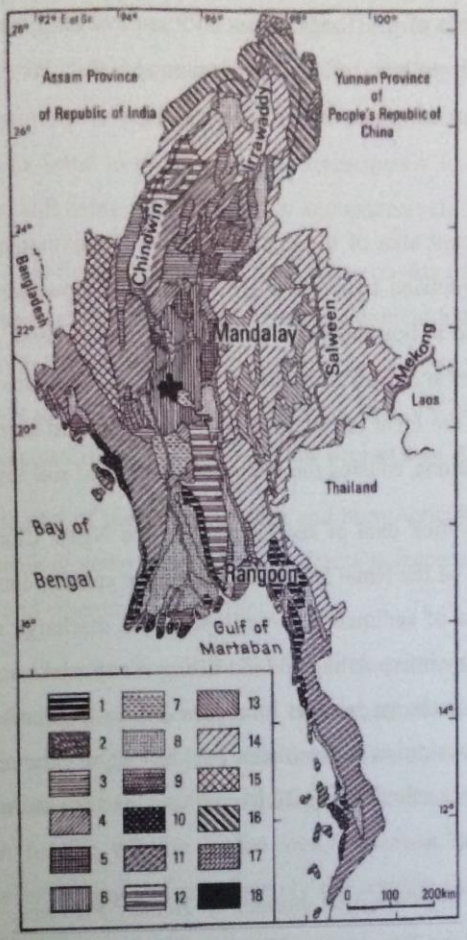


Figure 5.3-10 Soil Distribution Map of the Republic of the Union of Myanmar②

② Distribution of soils in Myanmar (modified after Rozanov, 1965; Bender, 1983).

1. Lateritic Soils and Laterites, 2. Red-brown Forest Soils of tropical evergreen forests, 3. Yellow-brown Forest Soils of tropical monsoon forests, 4. Cinnamon-brown Soils of tropical dry shrub stands, 5. Dark Compact Soils of tropical dry savannas, 6. Red-brown Soils of tropical dry savannas, 7. Primitive Gravelly Soils of tropical dry savannas. 8. Complex of Meadow, Bog, and Alluvial Soils of river valleys, 9. Salinized Soils of maritime lowlands, 10. Salty muds of tropical mangrove forests. 11. Mountain Red-brown Forest Soils of tropical evergreen forests, 12. Yellow-brown Mountain Forest Soils of tropical monsoon forests, 13. Red Earths and Yellow Earths, 14. Mountain Red Earths, 15. Complex of Mountain Soil, Meadow, and Red-Brown Forest Soils, 16. Brown Mountain-Forest. Soils of temperate coniferous-broadleaf forests, 17. Mountain-Meadow Alpine Soils, 18. Mountain red Soils. (revised by Rozanov in 1965, Bender, 19

Most of the project area of the Tongxinqiao HPP is covered by zonal soil, which is mainly composed of red soil, yellow soil and mountain red soil. With slight impact by human activities and high plant coverage, the water loss and soil erosion are not serious in general.

(2) Sediment

In the past, the upstream area of the dam site of the Tongxinqiao HPP is well covered by vegetation, and is dominated by the old-growth forests. However, there are some villages sporadically distributed at both banks of the river. In recent years, there are more and more human activities. Mines and quarries in different sizes are distributed in the Ngaw Chang Hka River Basin. Besides, the local vegetations are being damaged increasingly seriously due to the local road constructions, causing the increasing water and soil loss.

For the lack of observation data of sediment about the Ngaw Chang Hka River Basin and since the Chipwi HPP on the Nmai Hka River (the main stream) can provide a short series of actually measured data of sediment, the daily sediment discharge of this station in 1971 ~ 2009 can be obtained by interpolating and extending the synchronous actually measured data sediment discharge ~ discharge relation from June 2008 ~ November 2009, then the annual average sediment concentration is calculated as 0.334 kg/m^3, the annual average suspended load sediment quantity is calculated as 22.14 million t, and the sediment transport modulus is calculated as 1,086 t/km^2.a.

With reference to the *Hydrological Manual of Yunnan Province*, the modulus of erosion around the dam site of the Tongxinqiao HPP is calculated as 500 ~ 800 t/(km^2·a). In view of more and more human activities such as logging, quarrying, mining and road construction being conducted in this basin in recent years, vegetations have been damaged seriously and the soil erosion is getting more and more serious, so the sediment design of this Project shall depend on the sediment transport modulus of the Chipwi HPP. It is estimated that the dam site of the Tongxinqiao HPP has an annual average sediment concentration of 0.484 kg/m^3 and an annual average suspended load sediment quantity of 872,000 t. With reference to the experiences of the projects close to river basin in China, the bed load sediment quantity shall be taken as 15% of the suspended load sediment quantity, namely, 131,000 t.

5.4 Biological Components

The construction of the Ngaw Chan Kha Hydropower Project will not have a significant impact on wildlife in the area. At present, the only remaining viable wildlife habitats are on

the steep and relatively inaccessible slopes of undisturbed forests outside the project area. These areas will not be affected by the dams and / or other project-related activities. The areas of the dams and power plants are not significant for wildlife migration, breeding, or feeding. Whatever remaining wildlife found in the project area lives mostly in the higher elevations, and these have been and are still being indiscriminately and extensively hunted and captured.

The definition of wildlife used for the purpose of this study consists of 4 groups of animals: mammals, birds, reptiles, and amphibians. Forests are the dominant habitat of wildlife in the project area. Much of what had been forest in the project area has long since been cleared for shifting cultivation. Shifting cultivation is practiced widely near the Ngaw Chan Kha River and the dam sites. The forest classification for most of the project area is largely.

(1) Unstock forest that is part of the cycle of slash and burn agriculture and mixed forest that is located either on areas of steep land where the forest is inaccessible or on poor soils unsuitable for upland rice and other crop production.

(2) The richness of Ngaw Chan Kha's wildlife has less to do with conservation efforts than with the project area's low population density and consequent remaining extensive forest cover. Although there is hunting in the project area, the relative abundance of forest habitat and, in some cases, its considerable distance from human settlements and inaccessibility have provided some protection for the wildlife in the area. However, human population and development pressures are increasing and consequently the wildlife population has declined dramatically throughout the area.

5.4.1 Flora

5.4.1.1 Location of quadrats

In this flora survey, Tongxinqiao dam site and power house area were investigated for the plant species composition. A total of (6) study quadrates was set up in the study area. Floristic studies along this river segment with (6) quadrats (20 m x 20 m each) were carried out to clarify the ecological significant plant species. The detailed location sees Table 5.4-1 .

All plant species with dbh $\geq$ 4 cm were selected and recorded for the important value index (I.V.I) calculation. Other plant species which were found in these quadrats such as herbs, shrubs, climbers, epiphytes, bamboo, etc. were also enlisted and identified in this observation.

Table 5.4-1 GPS locations of the quadrats in the studied area

Quadrats	Representative GPS Points	
	Longitude	Latitude
1	98° 18' 42.0192" E	25° 58' 50.0226" N
2	98° 18' 6.7968" E	25° 59' 9.7008" N
3	98° 18' 2.469" E	25° 59' 17.9802" N
4	98° 17' 45.2436" E	25° 59' 47.3496" N
5	98° 17' 15.6588" E	26° 0' 23.022" N
6	98° 17' 11.1768" E	26° 0' 38.9196" N

5.4.1.2 Types of flora

Floristic surveys were conducted at the dam site and power house area. In this survey, a total of (55) tree(T) and small tree(ST) species were collected and identified (Table 5.4-2). The range of tree species recorded at the quadrats was 23-34. A total of 50 species of fern, climber, herb and shrub were recorded at the dam site and power house area. Herb and shrub species numbers were higher than other types of plant (Table 5.4-3).

Table 5.4-2 Occurrence of tree species at Tongxinqiao dam site and Power House area

Sr. No.	Plant species	Family	Habit	Occurrence in quadrats					
				Q1	Q2	Q3	Q4	Q5	Q6
1	*Steblus asper* Lour.	Moraceae	T	+	+	+	+	+	+
2	*Castanopsis sieboldii* (Makino) Hatus.	Fagaceae	T		+	+	+	+	+
3	*Dracontomelon mangiferum* Blume.	Anacardiaceae	T	+	+		+	+	+
4	*Careya aroborea* Roxb.	Lecythidaceae	T	+		+	+	+	+
5	*Anogeissum acuminata* Wall.	Rhizophoraceae	T	+	+		+	+	+
6	*Schima wallichii* (DC.) Korth.*	Theaceae	T	+	+	+	+	+	
7	*Dalbergia fusca* Pierre.	Fabaceae	T		+	+	+	+	+
8	*Litsaea polyantha* Juss.	Lauraceae	T	+	+	+	+	+	
9	*Lithocarpus pachyphylla* (Kurz.) Rehd.	Fagaceae	T	+	+	+	+	+	
10	*Araucaria excelsa* R. Br.	Araucariaceae	T	+	+		+	+	+
11	*Alstonia scholaris* R.Br.	Apocynaceae	T	+	+	+			+
12	*Bridelia stipularis* Blume.	Euphorbiaceae	T	+	+	+			+
13	*Persea* sp.	Lauraceae	T	+	+		+		+
14	*Strychnos nux-vomica* L.	Loganiaceae	T	+	+		+		+
15	*Solenocarpus indica* Wight & Arn.	Anacardiaceae	T			+	+	+	+
16	*Pinus khasya* Royle.	Pinaceae	T			+	+		+
17	*Betula alnoides* Buch-Ham.	Betulaceae	T	+		+		+	
18	*Averrhoa bilimbi* L.	Oxalidaceae	T		+	+		+	

19	*Lagerstroemia macrocarpa* Kurz.	Lythraceae	T		+	+	+		
20	*Phyllanthus pomiferus* Hk. F	Euphorbiaceae	ST				+	+	+
21	*Lagerstroemia parviflora* Roxb.	Lythraceae	T	+	+	+			
22	*Adina cordifolia* Hk.f.	Rubiaceae	T			+	+		+
23	*Syzygium jambos* (L.) Alston.	Myrtaceae	T	+		+	+		
24	*Pyrus granulosa* Bertol.	Rosaceae	ST	+			+	+	
25	*Abies* sp.	Pinaceae	T		+	+	+		
26	*Eugenia jambos* L.	Myrtaceae	T		+		+	+	
27	*Balanostreblus* sp.	Moraceae	ST	+	+		+		
28	*Anisoptera scaphula* (Roxb.)*	Dipterocarpaceae	T	+	+		+		
29	*Ficus chittagonga* Miq.	Moraceae	T		+		+	+	
30	*Bauhinia variegata* L.	Caesalpiniaceae	T			+	+		+
31	*Dalbergia rimosa* Roxb.	Fabaceae	ST	+	+	+			
32	*Crypteronia paniculata* Kurz.	Lythraceae	T		+	+		+	
33	*Debregeasia longifolia* (Burm.f.)Wedd.	Urticaceae	ST		+	+	+		
34	*Ehretia accuminata* R. Br.	Boranginaceae	T	+				+	+
35	*Eriobotrya bengalensis* (Roxb.) Hook.	Rosaceae	T			+		+	+
36	*Michelia floribunda* Finet & Gagnep.	Magnoliaceae	T		+			+	
37	*Mussaenda* sp.	Rubiaceae	ST		+				+
38	*Rhus chinensis* Mill.	Anacardiaceae	ST				+	+	
39	*Baccaurea sapida* Muell.	Euphorbiaceae	T		+	+			
40	*Callicarpa pedunculata* R. Br	Verbenaceae	ST			+		+	
41	*Lithocarpus aggregatus* Barnett. Rehd.	Fagaceae	T		+				+
42	*Acer oblongum* Wall.	Aceraceae	T				+	+	
43	*Magnolia rostrata* W. Smith.*	Magnoliaceae	T			+	+		
44	*Pterospermum semisagittatum* Ham.	Sterculiaceae	T				+		+
45	*Engelhardtia spicata* Bl.	Juglandaceae	T					+	+
46	*Wellendia tintorious* DC.	Rubiaceae	ST		+		+		
47	*Rhododendron glaycophyllum* Rehder.	Ericaceae	ST	+			+		
48	*Bridelia tomentosa* Bl.	Euphorbiaceae	ST	+	+				
49	*Juglans regia* L.	Juglandaceae	T		+		+		
50	*Trema orientalis* L.	Cannabaceae	ST	+		+			
51	*Mallotus oblongifolius* (Miq.) Mull.	Euphorbiaceae	T				+		+
52	*Dalbergia oliveri* Gamble ex. Prain.	Fabaceae	T			+			
53	*Eriobotrya japonica* (Thunb.) Lindl.	Rosaceae	T			+			
54	*Holarrhena antidysenterica* Wall.	Apocynaceae	T		+				
55	*Chaenomeles* sp.	Rosaceae	T			+			
			Total =	23	32	30	34	25	23

Table 5.4-3 The species of herb, fern, climber and shrub recorded during the survey period

Sr. No.	Family	Scientific Name	Myanmar name	Habit

	Ferns and Fern allies			
1	Adiantaceae	*Adiantum* sp.	Nil	H
2	Aspleniaceae	*Asplenium* sp.	Nil	Fern
3	Aspleniaceae	*Asplenium varian* Wall.	Nil	Fern
4	Blechanaceae	*Blechnum cartilagineum* Swartz.	Nil	Fern
5	Lygodiaceae	*Lygoidum flexuosum* (L.) Sw.	Nil	Fern
6	Osmundaceae	*Osmumda cinnamomea* L.	Da-yin-kauk	Fern
7	Polypodiaceae	*Platycerium bifurcatum* (Cav.) C. Chr.	Nil	H
8	Schizaeaceae	*Schizaea elegans* (Vahl.) Sco.	Nil	Fern
	Angiosperms			
9	Acanthaceae	*Justicia paniculate* Burm.	Say - kha - gyi	H
10	Acanthaceae	*Rungia* sp.	Nil	H
11	Acanthaceae	*Thumbergia grandiflora* Roxb.	Kyi- note- thi	C
12	Araliaceae	*Aralia spinosa* L	Hpaw	S
13	Araliaceae	*Trevesia palmata* Vis.	Hpaw -hpu	S
14	Asteraceae	*Inula* sp.	Nil	S
15	Asteraceae	*Mikania scandens* (L.) Willd.	Ja-ma-ni-nwe	C
16	Balsaminaceae	*Impatiens racemosa* DC.	Dan-pan	H
17	Berberidaceae	*Mahonia napaulensis* DC.	Shan-padauk	S
18	Berberidaceae	*Berberis thunbergii* DC.	Nil	S
19	Buddlejaceae	*Buddleja asiatica* Lour.	Kyaung-me-ku	S
20	Caesalpiniaceae	*Caesalpinia* sp.	Nil	WC
21	Caryophyllaceae	*Stellaria media* (L.) Vill.	Unknown	H
22	Chenopodiaceae	*Chenopodium ambrosioides* L	Say - mu	H
23	Cucurbitaceae	*Gymnopetalum conchinchinese* Kz.	Taw-kinmon	C
24	Cucurbitaceae	*Momordica dioica* Roxb.	Kyet - hin - kha - cho	C
25	Ericaceae	*Gaultheria fragrantissima* Wall.	Unknown	S
26	Ericaceae	*Rhododendron campanulatum* D.Don.	Taung- za- latt	S
27	Ericaceae	*Rhododendron glaucophyllum* Rehder.	Nil	S
28	Ericaceae	*Maesa semiserrata* Wall.	Kazaw	S
29	Euphorbiaceae	*Homonoia riparia* Lour.	Ye-tha-pyae	S
30	Fabaceae	*Apios carnea* Benth.ex Baker.	PeJ pan	C
31	Hypericaceae	*Hypericum choisianum* Wallich	Unknown	S
32	Hypericaceae	*Hypericum japonicum* Thumb.	Unknown	S
33	Loranthaceae	*Scurrula elata* Dancer.	Kyi - paung	S
34	Melastomataceae	*Melastoma malabathricum* L.	Oe-boke	S
35	Menispermaceae	*Stephania venosa* Spreng.	Taung Kya	C
36	Oleaceae	*Jasminum* sp.	Taw-sa-be	C
37	Onagraceae	*Ludwigia ocovalvis* (Jacq) Raven Kew Bull.	Lay Nyin Gyi	H
38	Orchidaceae	*Coelogyne nitida* (Wall. ex D. Don) Lind L.	Ngwe-hnin-phyu	EP
39	Orchidaceae	*Dendrobium* sp.	Mauk-kham-war	EP
40	Orchidaceae	*Dendrobium falconeri* Hook.	Myat Thit Khwa	EP

41	Oxalidaceae	*Oxalis corniculata* L.	Hmo-chin	H
42	Oxalidaceae	*Oxalis rosea* Jacq.	Hmo-chin	H
43	Piperaceae	*Houttuynia cordata* Thumb.	Htin-kwe	H
44	Poaceae	*Dendrocalamus brandisii* Kurz.	War-bo	Bamboo
45	Poaceae	*Arundo karka* Retz.	Kyu	S
46	Poaceae	*Thysanolaena* sp.	Myet; let-the	S
47	Polygonaceae	*Bistorta affinis* Greene.	Unknown	H
48	Polygonaceae	*Polygonum hydropiper* L.	Phet-phe	H
49	Portulacaceae	*Portulaca tuberosa* Roxb.	Gin Sin	H
50	Ranunculaceae	*Clematis smilacifolia* Wall.	Khwa-nyo	WC

C= Climber; EP= Epiphyte; H= Herb; S= Shrub; WC= Woody climber

5.4.1.3 Important value index of trees

The tree species with the highest IVI value were found to be *Steblus asper* Lour., *Castanopsis sieboldii* (Makino) Hatus., *Dracontomelon mangiferum* Blume., *Betula alnoides* Buch-Ham., and *Anogeissum acuminata* Wall.. In the recorded species. the species *Steblus asper* Lour., *Castanopsis sieboldii* (Makino) Hatus., and *Dracontomelon mangiferum* Blume. were dominant species and the species *Betula alnoides* Buch-Ham., and *Anogeissum acuminata* Wall. were found as common species (Table 5.4-4).

Table 5.4-4 Important Value Index (IVI) of tree species recorded in Tongxinqiao Dam site and Power House area

Sr. No.	Plant species	Family	Habit	Relative frequency (RF) in %	Relative density (RD) in %	Relative abundance dominance (RA) (Average abundance Total abundance value)	Important Value Index (IVI) in % (RF+RD+RA=IVI)
1	*Steblus asper* Lour.	Moraceae	T	3.59	4.03	1.97	9.59
2	*Castanopsis sieboldii* (Makino) Hatus.	Fagaceae	T	2.99	3.58	2.10	8.67
3	*Dracontomelon mangiferum* Blume.	Anacardiaceae	T	2.99	3.58	2.10	8.67
4	*Betula alnoides* Buch-Ham.	Betulaceae	T	1.79	3.13	3.06	7.98
5	*Anogeissum acuminata* Wall.	Rhizophoraceae	T	2.99	3.13	1.84	7.96
6	*Schima wallichii* (DC.) Korth.	Theaceae	T	2.99	2.69	1.57	7.25
7	*Dalbergia fusca* Pierre.	Fabaceae	T	2.99	2.69	1.57	7.25

8	*Averrhoa bilimbi* L.	Oxalidaceae	T	1.79	2.69	2.63	7
9	*Careya aroborea* Roxb.	Lecythidaceae	T	2.99	2.24	1.31	6
10	*Litsaea polyantha* Juss.	Lauraceae	T	2.99	2.24	1.31	6
11	*Lithocarpus pachyphylla* (Kurz.) Rehd.	Fagaceae	T	2.99	2.24	1.31	6
12	*Araucaria excelsa* R. Br.	Araucariaceae	T	2.99	2.24	1.31	6
13	*Alstonia scholaris* R.Br.	Apocynaceae	T	2.39	2.24	1.64	6
14	*Persea* sp.	Lauraceae	T	2.39	2.24	1.64	6
15	*Strychnos nux-vomica* L.	Loganiaceae	T	2.39	2.24	1.64	6
16	*Solenocarpus indica* Wight & Arn.	Anacardiaceae	T	2.39	2.24	1.64	6
17	*Pinus khasya* Royle.	Pinaceae	T	1.79	2.24	2.18	6
18	*Lagerstroemia parviflora* Roxb.	Lythraceae	T	1.79	2.24	2.18	6
19	*Anisoptera scaphula* (Roxb.) Pierre.	Dipterocarpaceae	T	1.79	2.24	2.18	6
20	*Bauhinia variegata* L.	Caesalpiniaceae	T	1.79	2.24	2.18	6
21	*Mussaenda* sp.	Rubiaceae	ST	1.19	1.79	2.63	5
22	*Bridelia stipularis* Blume.	Euphorbiaceae	T	2.39	1.79	1.31	5
23	*Lagerstroemia macrocarpa* Kurz.	Lythraceae	T	1.79	1.79	1.75	5
24	*Adina cordifolia* Hk.f.	Rubiaceae	T	1.79	1.79	1.75	5
25	*Syzygium jambos* (L.) Alston.	Myrtaceae	T	1.79	1.79	1.75	5
26	*Pyrus granulosa* Bertol.	Rosaceae	ST	1.79	1.79	1.75	5
27	*Abies* sp.	Pinaceae	T	1.79	1.79	1.75	5
28	*Eugenia jambos* L.	Myrtaceae	T	1.79	1.79	1.75	5
29	*Balanostreblus* sp.	Moraceae	ST	1.79	1.79	1.75	5
30	*Dalbergia rimosa* Roxb.	Fabaceae	ST	1.79	1.79	1.75	5
31	*Crypteronia paniculata* Kurz.	Lythraceae	T	1.79	1.79	1.75	5
32	*Ehretia accuminata* R. Br.	Boranginaceae	T	1.79	1.79	1.75	5
33	*Michelia floribunda* Finet & Gagnep.	Magnoliaceae	T	1.19	1.34	1.97	4
34	*Rhus chinensis* Mill.	Anacardiaceae	ST	1.19	1.34	1.97	4
35	*Baccaurea sapida* Muell.	Euphorbiaceae	T	1.19	1.34	1.97	4
36	*Callicarpa pedunculata* R. Br	Verbenaceae	ST	1.19	1.34	1.97	4
37	*Lithocarpus aggregatus* Barnett. Rehd.	Fagaceae	T	1.19	1.34	1.97	4
38	*Acer oblongum* Wall.	Aceraceae	T	1.19	1.34	1.97	4
39	*Pterospermum semisagittatum* Ham.	Sterculiaceae	T	1.19	1.34	1.97	4
40	*Bridelia tomentosa* Bl.	Euphorbiaceae	ST	1.19	1.34	1.97	4
41	*Phyllanthus pomiferus* Hk. F	Euphorbiaceae	ST	1.79	1.34	1.31	4
42	*Ficus chittagonga* Miq.	Moraceae	T	1.79	1.34	1.31	4
43	*Debregeasia longifolia* (Burm.f.)Wedd.	Urticaceae	ST	1.79	1.34	1.31	4
44	*Eriobotrya bengalensis* (Roxb.) Hook.	Rosaceae	T	1.79	1.34	1.31	4
45	*Dalbergia oliveri* Gamble ex. Prain.	Fabaceae	T	0.59	0.89	2.63	4
46	*Eriobotrya japonica* (Thunb.) Lindl.	Rosaceae	T	0.59	0.89	2.63	4
47	*Holarrhena antidysenterica* Wall.	Apocynaceae	T	0.59	0.89	2.63	4

48	*Chaenomeles* sp.	Rosaceae	T	0.59	0.89	2.63	4.11
49	*Magnolia rostrata* W. Smith.	Magnoliaceae	T	1.19	0.89	1.75	3.83
50	*Engelhardtia spicata* Bl.	Juglandaceae	T	1.19	0.89	1.31	3.39
51	*Wellendia tintorious* DC.	Rubiaceae	ST	1.19	0.89	1.31	3.39
52	*Rhododendron glaycophyllum* Rehder.	Ericaceae	ST	1.19	0.89	1.31	3.39
53	*Juglans regia* L.	Juglandaceae	T	1.19	0.89	1.31	3.39
54	*Trema orientalis* L.	Cannabaceae	ST	1.19	0.89	1.31	3.39
55	*Mallotus oblongifolius* (Miq.) Mull.	Euphorbiaceae	T	1.19	0.89	1.31	3.39
			Total =	**100**	**100**	**100**	**299**

5.4.1.4 Rare and Endangered Species

Among the recorded species, the species *Anisoptera scaphula* is listed as Critically endangered (CR) species under IUCN Red List and the two species, *Schima wallichii* and *Magnolia rostrata*, are Vulnerable species (VU) (Table 5.4-5).

Table 5.4-5 Threatened plant species recorded in the Tongxinqiao dam site and Power

Sr. No.	Species	Family	IUCN Status
1	*Schima wallichii* (DC.) Korth.	Theaceae	VU
2	*Anisoptera scaphula* (Roxb.) Pierre.	Dipterocarpaceae	CR
3	*Magnolia rostrata* Smith.	Magnoliaceae	VU

5.4.2 Fauna

Random Point count method was used for the bird survey and took the photograph of birds. Birds were observed with binoculars and identified aided with field guide. Nocturnal birds were observed when it becomes dusk. Point count and opportunistic methods were used to census the species richness and point counting was used to get the relative measure of bird abundance.

Distribution and presence of mammals were examined by conducting track and sign surveys. Sighting of prey species, tracks, scats, droppings were undertaken as data gathering in the field. Voucher specimens of tracks were taken in the forms of plaster casts, photographs or tracings. Questionnaire Survey was conducted and the results of questioning each individual informant were treated as a distinct sample.

The study on reptilian and amphibian species was based on active search and trapping method. Stratification of the habitat was relatively similar to that of mammal study. Reptilian and amphibian species were actively searched during the survey period. The collected specimens were preserved in 10% formalin for further identification in the laboratory.

5.4.2.1 Mammals

A total of 24 mammal species were recorded in Tongxinqiao Dam site and Power House areaTable 5.4-6). Among them 10 mammal species were listed as threatened species under IUCN Red List. Out of the recorded threatened species, 5 species were endangered species and another 5 species were recorded as vulnerable species.

Table 5.4-6 Mammal species recorded in Tongxinqiao Dam site and Power House area

Sr. No.	Scientific name	Common name	Family	IUCN Status	Remark
1	*Manis javanica*	Sunda Pangolin	Manidae	EN	Interview
2	*Manis pentadactyla*	Chinese Pangolin		EN	Interview
3	*M. mulatta*	Rhesus Macaque	Cercopithecidae	LC	Observed
4	*M.Macaque*	Assamese *assamensis*		NT	Interview
5	*Trachypithecus shortridgei*	Shortridge's Leaf Monkey		EN	Interview
6	*Hoolock hoolock*	Hoolock gibbon	Hylobatidae	EN	Voice
7	*Cuon alpinus*	Dhole	Canidae	EN	Tracks
8	*Ursus thibetanus*	Asian Black Bear	Ursidae	VU	Sign
9	*Helarctos malayanus*	Sun Bear		VU	Interview
10	*Martes flavigula*	Yellow-throated Marten	Mustelidae	LR	Interview
11	*Arctonyx collaris*	Hog Badger	Lutrinae	LR	Interview
12	*Lutrogale perspicillata*	Smooth Otter		LR	Interview
13	*Viverricula indica*	Small Indian Civet	Viverridae	LR	Interview
14	Paradoxurus hermaphrodites	Common Palm Civet		LR	Observed
15	Herpestes Javanicus	Small Asian Mongoose	Herpestidae	LR	Interview
16	Prionailurus bengalensis	Leopard Cat		LC	Interview
17	Catopuma temminckii	Asian Golden Cat		VU	Interview
18	Sus scrofa	Eurasian Wild Pig	Suidae	LR	Tracks
19	Rusa unicolor	Sambar	Cervidae	VU	Tracks
20	Muntiacus muntjak	Red Muntjac		LR	Tracks
21	Ratufa bicolor	Black Giant Squirrel	Sciuridae	LR	Observed
22	Callosciurus erythraeus	Pallaus's Squirrell		LR	Observed
23	Hystrix brachyuran	Malayan Porcupine	Histricidae	VU	Interview
24	Atherurus macrourus	Brush-tailed Porcupine		LR	Interview

5.4.2.2 Birds

A total of 117 bird species were observed in the Tongxinqiao Dam site and Power House area (Table 5.4-7). Among the observed species, 2 vulnerable species and 3 Near-threatened species were recorded. Most of the bird species were found as resident species residing in the area for all seasons. Out of the recorded species, some species were recorded as winter

visitors.

Table 5.4-7 Bird species recorded at in Tongxinqiao Dam site and Power House area

Sr. No.	Scientific name	Common name	Family	IUCN Status
1	*Bambusicola fytchii*	Mountain Bamboo Partridge	PHASIANIDAE	LR
2	*Gallus gallus*	Red Junglefowl	PHASIANIDAE	LR
3	*Arborophila atrogularis*	White-cheeked Partridge	PHASIANIDAE	NT
4	*Picumnus innominatus*	Speckled Piculet	PICIDAE	LR
5	*Celeus brachyurus*	Rufous Woodpecker	PICIDAE	LR
6	*Blythipicus pyrrhotis*	Bay Woodpecker	PICIDAE	LR
7	*Picus chlorolophus*	Lesser Yellownape	PICIDAE	LR
8	*Picus flavinucha*	Greater Yellownape	PICIDAE	LR
9	*Megalaima virens*	Great Barbet	MEGALAIMIDAE	LR
10	*Megalaima franklinii*	Golden-throated Barbet	MEGALAIMIDAE	LR
11	*Megalaima asiatica*	Blue-throated Barbet	MEGALAIMIDAE	LR
12	*Megalaima haemacephala*	Coppersmith Barbet	MEGALAIMIDAE	LR
13	*Buceros bicornis*	Great Hornbill	MEGALAIMIDAE	NT
14	*Aceros nipalensis*	Rufous-necked Hornbill	MEGALAIMIDAE	VU
15	*Upupa epops*	Common Hoopoe	UPUPIDAE	LR
16	*Harpactes erythrocephalus*	Red-headed Trogon	TROGONIDAE	LR
17	*Alcedo atthis*	Common Kingfisher	ALCEDINIDAE	LR
18	*Halcyon smyrnensis*	White-throated Kingfisher	HALCYONIDAE	LR
19	*Halcyon pileata*	Black-capped Kingfisher	HALCYONIDAE	LR
20	Nyctyornis athertoni	Blue-bearded Bee-eater	MEROPIDAE	LR
21	*Hierococcyx sparverioides*	Large Hawk Cuckoo	CUCULIDAE	LR
22	*Cuculus micropterus*	Indian Cuckoo	CUCULIDAE	LR
23	*Cypsiurus balasiensis*	Asian Palm Swift	APODIDAE	LR
24	*Otus spilocephalus*	Mountain Scops Owl	STRIGIDAE	LR
25	*Glaucidium brodiei*	Collared Owlet	STRIGIDAE	LR
26	*Caprimulgus indicus*	Grey Nightjar	CAPRIMULGIDAE	LR
27	*Streptopelia orientalis*	Oriental Turtle Dove	COLUMBIDAE	LR
28	*Streptopelia chinensis*	Spotted Dove	COLUMBIDAE	LR
29	*Ducula badia*	Mountain Imperial Pigeon	COLUMBIDAE	LR
30	*Spilornis cheela*	Crested Serpent Eagle	ACCIPITRIDAE	LR
31	*Accipiter badius*	Shikra	ACCIPITRIDAE	LR
32	*Ictinaetus malayensis*	Black Eagle	ACCIPITRIDAE	LR
33	*Bubulcus ibis*	Cattle Egret	ARDEIDAE	LR
34	*Pitta moluccensis*	Blue-winged Pitta	PITTIDAE	LR
35	*Psarisomus dalhousiae*	Long-tailed Broadbill	EURYLAIMINAE	LR
36	*Chloropsis hardwickii*	Orange-bellied Leafbird	IRENIDAE	LR
37	*Lanius schach*	Long-tailed Shrike	LANIIDAE	LR

5.4.2.1 Mammals

A total of 24 mammal species were recorded in Tongxinqiao Dam site and Power House areaTable 5.4-6). Among them 10 mammal species were listed as threatened species under IUCN Red List. Out of the recorded threatened species, 5 species were endangered species and another 5 species were recorded as vulnerable species.

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1	*Manis javanica*	Sunda Pangolin	Manidae	EN	Interview
2	*Manis pentadactyla*	Chinese Pangolin		EN	Interview
3	*M. mulatta*	Rhesus Macaque	Cercopithecidae	LC	Observed
4	*M.Macaque*	Assamese *assamensis*		NT	Interview
5	*Trachypithecus shortridgei*	Shortridge's Leaf Monkey		EN	Interview
6	*Hoolock hoolock*	Hoolock gibbon	Hylobatidae	EN	Voice
7	*Cuon alpinus*	Dhole	Canidae	EN	Tracks
8	*Ursus thibetanus*	Asian Black Bear	Ursidae	VU	Sign
9	*Helarctos malayanus*	Sun Bear		VU	Interview
10	*Martes flavigula*	Yellow-throated Marten	Mustelidae	LR	Interview
11	*Arctonyx collaris*	Hog Badger	Lutrinae	LR	Interview
12	*Lutrogale perspicillata*	Smooth Otter		LR	Interview
13	*Viverricula indica*	Small Indian Civet	Viverridae	LR	Interview
14	Paradoxurus hermaphrodites	Common Palm Civet		LR	Observed
15	Herpestes Javanicus	Small Asian Mongoose	Herpestidae	LR	Interview
16	Prionailurus bengalensis	Leopard Cat		LC	Interview
17	Catopuma temminckii	Asian Golden Cat		VU	Interview
18	Sus scrofa	Eurasian Wild Pig	Suidae	LR	Tracks
19	Rusa unicolor	Sambar	Cervidae	VU	Tracks
20	Muntiacus muntjak	Red Muntjac		LR	Tracks
21	Ratufa bicolor	Black Giant Squirrel	Sciuridae	LR	Observed
22	Callosciurus erythraeus	Pallaus's Squirrell		LR	Observed
23	Hystrix brachyuran	Malayan Porcupine	Histricidae	VU	Interview
24	Atherurus macrourus	Brush-tailed Porcupine		LR	Interview

5.4.2.2 Birds

A total of 117 bird species were observed in the Tongxinqiao Dam site and Power House area (Table 5.4-7). Among the observed species, 2 vulnerable species and 3 Near-threatened species were recorded. Most of the bird species were found as resident species residing in the area for all seasons. Out of the recorded species, some species were recorded as winter

visitors.

Table 5.4-7 Bird species recorded at in Tongxinqiao Dam site and Power House area

Sr. No.	Scientific name	Common name	Family	IUCN Status
1	*Bambusicola fytchii*	Mountain Bamboo Partridge	PHASIANIDAE	LR
2	*Gallus gallus*	Red Junglefowl	PHASIANIDAE	LR
3	*Arborophila atrogularis*	White-cheeked Partridge	PHASIANIDAE	NT
4	*Picumnus innominatus*	Speckled Piculet	PICIDAE	LR
5	*Celeus brachyurus*	Rufous Woodpecker	PICIDAE	LR
6	*Blythipicus pyrrhotis*	Bay Woodpecker	PICIDAE	LR
7	*Picus chlorolophus*	Lesser Yellownape	PICIDAE	LR
8	*Picus flavinucha*	Greater Yellownape	PICIDAE	LR
9	*Megalaima virens*	Great Barbet	MEGALAIMIDAE	LR
10	*Megalaima franklinii*	Golden-throated Barbet	MEGALAIMIDAE	LR
11	*Megalaima asiatica*	Blue-throated Barbet	MEGALAIMIDAE	LR
12	*Megalaima haemacephala*	Coppersmith Barbet	MEGALAIMIDAE	LR
13	*Buceros bicornis*	Great Hornbill	MEGALAIMIDAE	NT
14	*Aceros nipalensis*	Rufous-necked Hornbill	MEGALAIMIDAE	VU
15	*Upupa epops*	Common Hoopoe	UPUPIDAE	LR
16	*Harpactes erythrocephalus*	Red-headed Trogon	TROGONIDAE	LR
17	*Alcedo atthis*	Common Kingfisher	ALCEDINIDAE	LR
18	*Halcyon smyrnensis*	White-throated Kingfisher	HALCYONIDAE	LR
19	*Halcyon pileata*	Black-capped Kingfisher	HALCYONIDAE	LR
20	Nyctyornis athertoni	Blue-bearded Bee-eater	MEROPIDAE	LR
21	*Hierococcyx sparverioides*	Large Hawk Cuckoo	CUCULIDAE	LR
22	*Cuculus micropterus*	Indian Cuckoo	CUCULIDAE	LR
23	*Cypsiurus balasiensis*	Asian Palm Swift	APODIDAE	LR
24	*Otus spilocephalus*	Mountain Scops Owl	STRIGIDAE	LR
25	*Glaucidium brodiei*	Collared Owlet	STRIGIDAE	LR
26	*Caprimulgus indicus*	Grey Nightjar	CAPRIMULGIDAE	LR
27	*Streptopelia orientalis*	Oriental Turtle Dove	COLUMBIDAE	LR
28	*Streptopelia chinensis*	Spotted Dove	COLUMBIDAE	LR
29	*Ducula badia*	Mountain Imperial Pigeon	COLUMBIDAE	LR
30	*Spilornis cheela*	Crested Serpent Eagle	ACCIPITRIDAE	LR
31	*Accipiter badius*	Shikra	ACCIPITRIDAE	LR
32	*Ictinaetus malayensis*	Black Eagle	ACCIPITRIDAE	LR
33	*Bubulcus ibis*	Cattle Egret	ARDEIDAE	LR
34	*Pitta moluccensis*	Blue-winged Pitta	PITTIDAE	LR
35	*Psarisomus dalhousiae*	Long-tailed Broadbill	EURYLAIMINAE	LR
36	*Chloropsis hardwickii*	Orange-bellied Leafbird	IRENIDAE	LR
37	*Lanius schach*	Long-tailed Shrike	LANIIDAE	LR

38	*Lanius cristatus*	Brown Shrike	LANIIDAE	LR
39	*Lanius tephronotus*	Grey-backed Shrike	LANIIDAE	LR
40	*Cissa chinensis*	Common Green Magpie	CORVINAE	LR
41	*Dendrocitta formosae*	Grey Treepie	CORVINAE	LR
42	*Dendrocitta frontalis*	Collared Treepie	CORVINAE	LR
43	*Rhipidura hypoxantha*	Yellow-bellied Fantail	DICRURINIDAE	LR
44	*Dicrurus leucophaeus*	Ashy Drongo	DICRURINIDAE	LR
45	*Dicrurus aeneus*	Bronzed Drongo	DICRURINIDAE	LR
46	*Dicrurus remifer*	Lesser Racket-tailed Drongo	DICRURINIDAE	LR
47	*Dicrurus paradiseus*	Greater Racket-tailed Drongo	DICRURINIDAE	LR
48	*Tephrodornis gularis*	Large Woodshrike	MALACONOTIDAE	LR
49	*Cinclus pallasii*	Brown Dipper	CINCLIDAE	LR
50	*Myophonus caeruleus*	Blue Whistling Thrush	MUSCICAPIDAE	LR
51	*Eumyias thalassina*	Verditer Flycatcher	MUSCICAPIDAE	LR
52	*Niltava macgrigoriae*	Small Niltava	MUSCICAPIDAE	LR
53	*Cyornis unicolor*	Pale Blue Flycatcher	MUSCICAPIDAE	LR
54	*Cyornis rubeculoides*	Blue-throated Flycatcher	MUSCICAPIDAE	LR
55	*Cyornis tickelliae*	Tickell's Blue Flycatcher	MUSCICAPIDAE	LR
56	*Culicicapa ceylonensis*	Grey-headed Canary Flycatcher	MUSCICAPIDAE	LR
57	*Sturnus malabaricus*	Chestnut-tailed Starling	STURNIDAE	LR
58	*Sitta nagaensis*	Chestnut-vented Nuthatch	SITTIDAE	LR
59	*Sitta frontalis*	Velvet-fronted Nuthatch	SITTIDAE	LR
60	*Sitta formosa*	Beautiful Nuthatch	SITTIDAE	VU
61	*Parus monticolus*	Green-backed Tit	PARIDAE	LR
62	*Parus spilonotus*	Yellow-cheeked Tit	PARIDAE	LR
63	*Aegithalos concinnus*	Black-throated Tit	AEGITHALIDAE	LR
64	*Hirundo striolata*	Striated Swallow	HIRUNDININAE	LR
65	*Spizixos canifrons*	Crested Finchbill	PYCNONOTIDAE	LR
66	*Pycnonotus striatus*	Striated Bulbul	PYCNONOTIDAE	LR
67	*Pycnonotus melanicterus*	Black-crested Bulbul	PYCNONOTIDAE	LR
68	*Alophoixus flaveolus*	White-throated bulbul	PYCNONOTIDAE	LR
69	*Hypsipetes mcclellandii*	Mountain Bulbul	PYCNONOTIDAE	LR
70	*Hypsipetes leucocephalus*	Black Bulbul	PYCNONOTIDAE	LR
71	*Prinia superciliaris*	Hill Prinia	CISTICOLIDAE	LR
72	*Tesia castaneocoronata*	Chestnut-headed Tesia	SYLVIIDAE	LR
73	*Cettia fortipes*	Brownish-flanked Bush Warbler	SYLVIIDAE	LR
74	*Cettia flavolivacea*	Aberrant Bush Warbler	SYLVIIDAE	LR
75	*Acrocephalus aedon*	Thick-billed Warbler	SYLVIIDAE	LR
76	*Orthotomus sutorius*	Common Tailorbird	SYLVIIDAE	LR
77	*Phylloscopus affinis*	Tickell's Leaf Warbler	SYLVIIDAE	LR
78	*Phylloscopus cantator*	Yellow-vented Warbler	SYLVIIDAE	LR
79	*Abroscopus superciliaris*	Yellow-bellied Warbler	SYLVIIDAE	LR

80	*Megalurus palustris*	Striated Grassbird	MEGALURINAE	LR
81	*Garrulax leucolophus*	White-crested Laughingthrush	GARRULACIDAE	LR
82	*Garrulax monileger*	Lesser Necklaced Laughingthrush	GARRULACIDAE	LR
83	*Garrulax pectoralis*	Greater Necklaced Laughingthrush	GARRULACIDAE	LR
84	***Garrulax ruficollis***	Rufous-necked Laughingthrush	GARRULACIDAE	LR
85	*Garrulax nuchalis*	Chestnut-backed Laughingthrush	GARRULACIDAE	NT
86	*Garrulax erythrocephalus*	Chestnut-crowned Laughingthrush	GARRULACIDAE	LR
87	*Liocichla phoenicea*	Red-faced Liocichla	GARRULACIDAE	LR
88	*Pellorneum tickelli*	Buff-breasted Babbler	SYLVIDAE	LR
89	***Pellorneum ruficeps***	Puff-throated Babbler	SYLVIDAE	LR
90	*Xiphirhynchus superciliaris*	Slender-billed Scimitar Babbler	SYLVIDAE	LR
91	*Pnoepyga pusilla*	Pygmy Wren Babbler	SYLVIDAE	LR
92	*Spelaeornis formosus*	Spotted Wren Babbler	SYLVIDAE	LR
93	*Stachyris ruficeps*	Rufous-capped Babbler	SYLVIDAE	LR
94	***Stachyris chrysaea***	Golden Babbler	SYLVIDAE	LR
95	*Stachyris nigriceps*	Grey-throated Babbler	SYLVIDAE	LR
96	***Gampsorhynchus rufulus***	White-hooded Babbler	SYLVIDAE	LR
97	*Leiothrix argentauris*	Silver-eared Mesia	SYLVIDAE	LR
98	*Alcippe poioicephala*	Brown-cheeked Fulvetta	SYLVIDAE	LR
99	*Alcippe morrisonia*	Grey-cheeked Fulvetta	SYLVIDAE	LR
100	*Alcippe nipalensis*	Nepal Fulvetta	SYLVIDAE	LR
101	***Yuhina castaniceps***	Striated Yuhina	SYLVIDAE	LR
102	*Yuhina bakeri*	White-naped Yuhina	SYLVIDAE	LR
103	*Yuhina occipitalis*	Rufous-vented Yuhina	SYLVIDAE	LR
104	*Paradoxornis gularis*	Grey-headed Parrotbill	SYLVIDAE	LR
105	*Dicaeum ignipectus*	Fire-breasted Flowerpecker	NECTARINIIDAE	LR
106	*Aethopyga gouldiae*	Mrs Gould's Sunbird	NECTARINIINAE	LR
107	*Aethopyga saturata*	Black-throated Sunbird	NECTARINIINAE	LR
108	*Arachnothera magna*	Streaked Spiderhunter	NECTARINIINAE	LR
109	*Passer rutilans*	Russet Sparrow	PASSERIDAE	LR
110	Passer montanus	Eurasian Tree Sparrow	PASSERIDAE	LR
111	*Motacilla alba*	White Wagtail	MOTACILLIDAE	LR
112	***Motacilla citreola***	Citrine Wagtail	MOTACILLIDAE	LR
113	*Anthus hodgsoni*	Olive-backed Pipit	MOTACILLIDAE	LR
114	***Anthus rufulus***	Paddyfield Pipit	MOTACILLIDAE	LR
115	*Lonchura striata*	White-rumped Munia	ESTRILDIDAE	LR
116	*Lonchura punctulata*	Scaly-breasted Munia	ESTRILDIDAE	LR
117	*Emberiza pusilla*	Little Bunting	EMBERIZIDAE	LR

5.4.2.3 Amphibians and Reptiles

A total of 3 reptile species and 1 amphibian species were recorded during the survey period at Tongxinqiao Dam site and Power House area. No threatened species of reptile and amphibian

species was found during the survey period. (seeing Table 5.4-8)

Table 5.4-8 Reptile and Amphibian species recorded during the survey period

Sr. No.	Scientific Name	Common Name	Family	IUCN Status	CITIES Status
1	*Ahaetulla nasuta*	Long-nosed whip snake	Colubridae	Lc	none
2	*Calotes emma*	Forest crasted lizard	Agamidae	Lc	none
3	*Mabuya multifasciata*	Many-lined sun skink	Scincidae	Lc	none
4	*Bufo melanostatus*	Common toad	Bufonidae	Lc	none

5.4.2.4 Fishes

A total of 15 fish species at upstream and downstream were recorded during the survey period (Table 5.4-9 and Table 5.4-10) , where members of Family Cyprinidae dominate the fish fauna. It was reportedly recorded that the fishes were in small population size. Fishery activities were not observed in the area. The recorded fish species were not listed under IUCN Red List. The recorded fish species are not listed under long-distance longitudinal migratory species. According to the interview result, the fishes were not main sources for the consumption of the local people.

Table 5.4-9 Fish species recorded at upstream site

Sr. No.	Scientific Name	Common Name	Family	IUCN Status	Remark
1	*Puntius chola*	Barb	Cyprinidae	LR	Interview
2	*Labeo calbasu*	Carp	Cyprinidae	LR	Interview
3	*Labeo boga*	Carp	Cyprinidae	LR	Interview
4	*Cirrhinus mrigala*	Carp	Cyprinidae	LR	Interview
5	*Osteobrama belangeri*	Carp	Cyprinidae	LR	Interview
6	*Garra lamta*	Carp	Cyprinidae	LR	Interview
7	*Tor brevifilis*	Carp	Cyprinidae	LR	Interview
8	*Heteropneustes fossilis*	Stinging catfish	Heteropneustidae	LR	Interview
9	*Mystus montanus*	Striped dwarf catfish	Bagridae	LR	Interview
10	*Mystus vittatus*	Catfish	Bagridae	LR	Interview
11	*Mystus bleekeri*	Catfish	Bagridae	LR	Observed
12	*Mystus montanus*	Catfish	Bagridae	LR	Observed
13	*Channa striatus*	Striped snake head	Channidae	LR	Interview
14	*Channa orientalis*	Brown snakehead	Channidae	LR	Interview
15	*Glyptothorax dorsalis*	Catfish	Sisoridae	LR	Interview

Table 5.4-10 Fish species recorded at downstream site

Sr. No.	Scientific Name	Common Name	Family	IUCN Status	Remark
1	*Puntius chola*	Barb	Cyprinidae	LR	Interview
2	*Labeo calbasu*	Carp	Cyprinidae	LR	Interview
3	*Labeo angra*	Carp	Cyprinidae	LR	Observded
4	*Cirrhinus mrigala*	Carp	Cyprinidae	LR	Interview
5	*Osteobrama belangeri*	Carp	Cyprinidae	LR	Interview
6	*Garra lamta*	Carp	Cyprinidae	LR	Interview
7	*Tor brevifilis*	Carp	Cyprinidae	LR	Interview
8	*Heteropneustes fossilis*	Stinging catfish	Heteropneustidae	LR	Interview
9	*Mystus vittatus*	Catfish	Bagridae	LR	Interview
10	*Mystus bleekeri*	Catfish	Bagridae	LR	Observed
11	*Mystus montanus*	Catfish	Bagridae	LR	Observed
12	*Channa striatus*	Striped snake head	Channidae	LR	Interview
13	*Channa orientalis*	Brown snakehead	Channidae	LR	Interview
14	*Glyptothorax dorsalis*	Catfish	Sisoridae	LR	Interview
15	*Glyptothorax cavia*	Catfish	Sisoridae	LR	Interview

5.4.2.5 Benthonic organisms

Benthos species were rare in both upstream and upstream sites. Three species at upstream site and two species at downstream site were recorded. Two mollusc species were found during the survey periood. The earthworm species *Notoscolex striatus* was observed both in upstream and downstream sites (Table 5.4-11and Table 5.4-12).

Table 5.4-11 Benthos species recorded at upstream site

Sr. No.	Species	Family	Group	Remark
1	*Pila polita*	Ampullariidae	Mollusk	uncommon
2	*Pheretima andersoni*	Megascolecidae	Earthworm	uncommon
3	*Notoscolex striatus*	Megascolecidae	Earthworm	uncommon

Table 5.4-12 Benthos species recorded at downstream site

Sr. No.	Species	Family	Group	Remark
1	*Clea helena*	Buccinidae	Mollusk	uncommon
2	*Notoscolex striatus*	Megascolecidae	Earthworm	uncommon

5.4.2.6 Planktons

A total of 9 plankton species were recorded at upstream site, where 5 species were observed as zooplankton species and the next 4 species as phytoplankton species. Among the recorded

species, *Closterium archerianum* was found as common species. Seven plankton species were found from the samples collected from downstream site. Among these recorded plankton species, three species were found as zoolplankton species and two species as phytoplankton species (Table 5.4-13and Table 5.4-14).

Table 5.4-13 Plankton species recorded at upstream site

Sr. No.	Species	Group	Family	Remark
1	*Diffugia lebes*	Zoolplankton	Diffugiidae	Uncommon
2	*Spathidium spathula*	Zoolplankton	Didiniidae	Uncommon
3	*Notholca acuminate*	Zoolplankton	Brachiondae	Uncommon
4	*Brachionus falcatus*	Zoolplankton	Brachiondae	Uncommon
5	*Bosmina sp*	Zoolplankton	Bosminidae	Uncommon
6	*Closterium archerianum*	*Phytoplankton*	Desmidiaceae	Uncommon
7	*Spirogyra protecta*	*Phytoplankton*	Zygnemataceae	Uncommon
8	*Oscillatoria subbrevis*	*Phytoplankton*	Oscillatoriaceae	Uncommon
9	*Tabellariae sp*	*Phytoplankton*	Fragilariaceae	Uncommon

Table 5.4-14 Plankton species recorded at downstream site

Sr. No.	Species	Group	Family	Remark
1	*Diffugia lebes*	Zoolplankton	Diffugiidae	Uncommon
2	*Spathidium spathula*	Zoolplankton	Didiniidae	Uncommon
3	*Brachionus falcatus*	Zoolplankton	Brachiondae	Uncommon
4	*Closterium archerianum*	*Phytoplankton*	Desmidiaceae	Uncommon
5	*Spirogyra protecta*	*Phytoplankton*	Zygnemataceae	Uncommon
6	*Lyngbya contorta*	*Phytoplankton*	Oscillatoriaceae	Uncommon
7	*Tabellariae sp*	*Phytoplankton*	Fragilariaceae	Uncommon

5.5 Socio-economic Components

5.5.1 Infrastructures

Chiphwi is suffering from poor and irregular system of transportation. The road passes through Bala Min Htin Bridge across the Ayeyarwady River and from Wai Maw to Chiphwi is 140 kilometers (87 miles), landslides often is experienced along the N'Mai Hka. From Chiphwi to Pang Wa is a 67.6 kilometers (42 miles) all season hard surface road. A motor road from Pang Wa to Hpimaw through Hpare-Nazumbaw-Chichyang –Jigyaw, Gam Hkun 117 kilometers (110 miles) was opened since 2002, but it can be used only during the open season. There is also a road between Pang Wa to Ngawchang Hka Bridge a junction to Hsaw Law and Hpimaw. Nowadays, local ethnic leaders upgraded many of the foot path system to

hard surface road system. Sometimes cars used on these roads encounter landslides in rainy season due to steep slopes. A bridge across the N'Mai Hka was constructed in 2003-2004 connecting Zanaung Yang and Chiphwi. Before the construction of a new concrete bridge, a suspension bridge of cane was used instead. Chiphwi- Pang Wa, Chiphwi-Hsaw Law, Chiphwi- N'Jang Yang, Chiphwi-Hpimaw hard surface motor roads are used during the open season. Road transportation in Chiphwi is mostly footpath system. Local people use this footpath system of mountain transportation and they also have a custom to meet their relatives yearly.

5.5.2 Population and Ethnic Groups

Population is one of the important socio-economic conditions of a township. In 2013, the total population of Chipwi Township was 22,687 persons. (Table 3.1 and Table 3.2) Number of female population is higher than that of male population in Hsawlaw Township. Among the villages of Chipwi Township, the highest number of population is found in Chipwi Town (11,321 persons) and he lowest population is found in Byawloi Village (only 56 persons). Among the villages of Hsawlaw Township, Hsawlaw Town is the highest with 7,070 persons and Larchin Village is the second highest with only 1,917 persons. Population density of Chipwi and Hsawlaw townships are 17 and 10 persons per square density.

The main ethnic group in the assessment area is Kachin people, most of which are Christians.

5.5.3 People's Health

Health care delivery was provided by public institution and private clinics and personnel in Chipwi Township.

The township health department provides primary health care, family health, nutrition, child development, environmental health, communicable disease control- including tuberculosis, malaria, diarrhea and dysentery, childhood infections, expanded immunization; and non-communicable disease control such as cardiovascular diseases including hypertension, accidents and injuries and so on.

The commonest diseases recorded by the health department were, Acute Respiratory Infections (ARI) and pneumonia, Malaria, Diarrhea, Dysentery, accident and injury, in order of frequency.

5.5.4 Education

There are 2 senior middle schools, 4 middle schools and 52 primary schools in Chibwe Town in 2013. The ratio of teachers to students was 1:22 in senior middle schools, 1:18 in middle schools and 1:19 in primary schools.

5.5.5 Minerals, Cultural Relics and Historic Sites

No mineral, cultural relic or historic site is found in the range of the reservoir area, so there is not the issue of submerging mineral, cultural relic or historic site. There are limited permanent residents and farmland distributed in the range of the reservoir area, and there are basically not any fruit trees or planted trees of economic values, without finding any important building or industrial or mining enterprise.

As to the cultural hesitage, the status and history of lineage, ethnic, dress and ornaments, religion and so on are shown in the Appendix 5.

5.5.6 Economic Conditions

Landuse of Chipwi Township includes cultivated land, virgin land and non-cultivated land. In 2013, there were 1,651 hm^2 of cultivated land and 228,387hm^2 of non-cultivated land. Cultivated land included Le (paddy field) , Ya (496.8 hm^2), Garden (621.2 hm^2) and Taungyar (373 hm^2). The main crops are paddy, corn, walnut and vegetables. Cows and buffalos are mainly used in agricultural works. Chicken, pig and duck are important livestock for home consumption. Walnut is the main income source of their livelihood.

5.6 Environmental Quality

5.6.1 Water Quality

Water quality is monitored by the REM. The sampling sites are shown in Table 5.2-1 and Figure 5.2-1. Water samples were sent to the Department of Fishery, Government's laboratory and Myanmar Environment Institute. The labortary result can be seen in the Appendix 3. Water quality results are shown in Table 5.6-1.

We propose to use the WHO drinking water standards, US Environmental Protection Agency's (EPA) standards and Chinese standards to assess the water quality. The results shows that some indexes meet the requirements from the proposed standards. But there are 4 indexes are exceeding the demands of standards. They are Iron, lead, mercury and fecal coliforms. iron

meets the requirement only one station in six comparing with the proposed standards. There are two stations' results over the standards in lead. The mercury meets the standards from the WHO and EPA, but it doesn't meet the requirement of China. One station's value of fecal coliforms doesn't meet the demands. In sum, the surface water quality does not meet thestandards.

Table 5.6-1 Water quality results of the samples collected in Tonxinqiao area

Parameter	NSW-8	NSW-9	NSW-10	NSW-11	NSW-12	NSW-13	WHO3 (Drinking Water Quality Guideline)	EPA4 (Human Health, Consumption of Water & Organism)	China5 Standard（Centralized drinking water source of surface water）
Flow rate / Velocity (m/s)	1.2	0.6	0.4	0.4	0.3	0.6-0.8	-	-	-
Weather	Sunny	Sunny	Partly-Cloudy	Sunny	Sunny	Sunny	-	-	-
Transparency	Low	Medium	Low	Medium	High	Medium	-	-	-
Temperature (C°)	12.03	10.69	11.16	14.37	16.04	15.71	-	-	-
pH	8.34	8.14	8.43	8.14	8.05	8.23	6-9	6.5-8.5	6-9
DO (mg/L)	8.54	8.37	8.85	8.35	9.24	8.22	-	≥2	≥5
Turbidity (FNU)	441	17.7	528	66.3	11.2	66.9	-	-	-
Total Hardness (mg/L)	70	50	64	42	78	44	-	-	-
Biological Oxygen Demand (mg/L)	2.5	2.5	2.0	2.0	2.5	2.5	50	50	4
Chemical Oxygen Demand (mg/L)	1.10	5.15	6.52	2.57	1.10	1.84	-	-	20
Suspended Solid (mg/L)	33	36	43	34	55	35	-	-	-
Copper (mg/L)	0.061	0.062	0.013	0.008	ND	0.030	2	1.3	1.0
Ortho Phosphate (mg/L)	5.0	5.5	5.0	5.5	5.5	5.0	-	-	-
Sulphate (mg/L)	0.02	0.01	0.02	0.02	0.02	0.02	250	-	250
Sulfide (mg/L)	nil	nil	nil	nil	nil	nil	-	-	0.2
Iron (mg/L)	3.0	0.5	0.3	0.5	0.01	5.0	0.3	0.3	0.3
Lead (mg/L)	0.0094	0.0169	0.0026	0.0036	0.0093	0.0129	0.01	0.015	0.05
Mercury (mg/L)	0.0006	0.0007	0.0008	0.0009	0.0010	0.0011	0.006	0.002	0.0001
Arsenic (mg/L)	0.0041	0.0039	0.0038	0.0029	0.0027	0.0025	0.01	0.01	0.05
Fecal Coliforms (cfu/100ml)	$1x10^2$	$2x10^2$	$3.3x10^3$	0	0	0	1000	---	1000

[3] Refer to Guidelines for Drinking-water Quality, WHO 2008
[4] Refer to National Recommended Water Quality Criteria – Correction, EPA 822-Z-99-001, 1999
[5] Refer to the surface water quality standards from China, GB3838-2002

5.6.2 Atmospheric and Acoustic Environment

It can be known through reference to the standards of Thailand and Japan and comparison to the field monitoring results that the assessment area has a relatively high quality of air and acoustic environment around. Considering there are no big source of pollution of air and noise, the main sources are only from the agricultural production and daily life that it has good environmental quanlity. The monitoring results are seen in Table 5.6-2 and Table 5.6-3 .

1) Air quality

Table 5.6-2 Monitoring results of air quality

No.	Parameters	NAN-5	NAN-6	standards	Remards
1	SO_2	0.008	0.005	0.12	Thailand
2	CO	1.047	0.690	10	Japan
3	NO_2	0.016	0.027	0.04	Japan
4	TSP	0.050	0.071	0.33	Thailand
5	PM_{10}	0.044	0.065	0.12	Thailand

2) noise

Table 5.6-3 Monitoring results of acoustic environment

Parameters	NAN-5	NAN-6	standards	达标情况
L_{Aeq}	55.14	65.63	70	Thailand

5.7 Major Environmental Issues in the Assessment Area

According to the site investigation information furnished by REM and results of KHIDI's several on-the-spot surveys, the area where Tongxinqiao HPP is located does not involve any environmentally sensitive area defined by the national and local government of Myanmar. Presently, the main problems in the assessment area include destructive cutting of forest, slash-and-burn cultivation, and loss of biodiversity and soil erosion.

6 Impact Assessment and Mitigation Measures

6.1 Methods and Technologies

The common technical methods for forecasting and assessing environmental impacts include mathematical model method, physical model method, analogy analysis method, and professional judgment method, etc. For example, it is mainly to use mathematical model method to forecast the amount of pollutants generated, runoff – reservoir storage ratio method to forecast water temperature, and ecological mechanism method to forecast the impacts on the terrestrial ecosystem and the aquatic ecosystem. The rating matrix are used to assess the total impacts. the content and formulating significance are as follows.

The matrix is shown as follows. The methods to calculate the significance of different environmental impacts are mainly depended on the mechanism analysis and historical experience and monitoring results. The rating matrix are shown in table 6.1-1.

The methods on formulating the significance include the ecological mechanism deducing method for the ecological impacts, the standards value comparing method for the environmental facts with standard value such as water quality, noise and air, the significance adding happening probability method for the dam breaking significance et.

Table 6.1-1 The impacts rating matrix

Environmental Aspect/Issue	Water	Air	Solid waste	Noise	Society	Ecology	Total
The pre-construction period							
FS survey	D	D	D	D	A+	B+	A+
EIA studies	D	D	D	D	A+	B+	A+
Construction period							
Quarry and borrow pit mining	B-	B-	B-	A-	B+	B-	B-
The aggregate processing system	B-	B-	B-	B-	B+	B-	B-
concrete mixing system	B-	B-	B-	B-	B+	B-	B-
Truck and machine maintaining and repairing	B-	B-	B-	B-	B+	B-	B-
Personnel live	B-	B-	B-	B-	B+	B-	B-
Wastewater treating	A+	D	D	D	D	D	A+
Occupation of land	D	D	D	D	B-	B-	B-
Material transporting	B-	B-	B-	B-	B-	B+	B-
Other economic activity	B-	B-	B-	B-	B-/+	B-	B-
Healthy management	D	D	D	D	D	B+	B+
Resettlement	B-	B-	B-	B-	B+	B-	B+
Other Materials processing such as wood	B-	B-	B-	B-	B-	B+	B-

Tunnel construction	A-	B-	B-	B-	B+	B-	B-
Dam filling	B-	B-	B-	B-	A+	D	B-
Field management	B+	B+	B+	B+	B+	B+	B+
Operation period							
Field Managing especially environmental management	B+	B+	B+	B+	B+	B+	B+
Energy production	B-	B-	B-	B-	B+	B-	B+
Environmental risk including earthquake and flood	A-	A-	A-	A-	A-	A-	A-
Decommissioning Period							
Still using	D	D	B-	B-	A+	D	B+
Removing	B-	B-	B-	B-	B-	B-	B-
Total							B-

A-: Significant Negative Impact A+: Significant Positive Impact
B-: Some Negative Impact B+: Some Positive Impact
C: Impacts are not clear, need more investigation
D: No Impacts or Impacts are negligible, no further study required

The scope of the assessment is the same with the Chapter 5.

The main impact assessment scope map is shown in attached map 12. It mainly involves the ecological affected area. As to the atmosphere and acoustic impacts, it is just skirting to 200m of the construction scope. Other environmental factors, such as hydrology, climate, solid waste and so on, impact area are nearly in the ecologicl impacts scope. The social impacts area should be confirmed by municiple boundary.

6.2 Environmental impacts assessment

6.2.1 Impacts on Water Environment

6.2.1.1 Changes of Hydrological Regime

(1) Environmental Impacts During the Construction Period

During the construction period, it is to retain water with cofferdam for construction of the dam, water enters the D/S through diversion tunnel, without any impact on the hydrological regime of the river channel.

(2) Environmental Impacts During the Operation Period

① Impacts of Initial Water storage

According to the construction programme and procedures of Tongxinqiao HPP, it is to start initial water storage after the diversion tunnel is closed in early May in Year 4.

The size of Tongxinqiao Reservoir is relatively small, the storage capacity under the MOL is only 1.63 million m^3, and the storage capacity under FSL is only 5.14×10^6 m^3. Through calculations, the reservoir will be closed for water storage in early May, and it will take 13.4h to store water to the MOL. Without considering the effect of power generation, it will take 35.8h to store water to the FSL. The initial water storage time will be very short, with limited impacts on hydrological regime.

②Changes of Monthly Runoffs D/S of the Dam

Tongxinqiao HPP will be conducted the headrace-type development, comprising concrete gravity dam, headrace tunnel, surge shaft, penstock and ground powerhouse, etc. After Tongxinqiao HPP is completed, the FSL of the reservoir will be El. 1,075m, the corresponding storage capacity will be $5.14\times10^6m^3$, while the MOL will be El. 1,060m, and the corresponding storage capacity will be $1.63\times10^6m^3$. The perennial average discharge of the HPP will be $124m^3/s$. Water diversion of the HPP will not reduce the total quantity of downstream water of the powerhouse, . During the low-water season,the runoffs will be greatly reduced from D/S of the dam to the powerhouse. The length of water-reducing reach is about 14.7km. The water reduction period will generally be 7 months (November to the following May). However, in the river channel D/S of the dam site, there is a tributary of Chai Maw Hka river. the confluence is about 2.96km away from the dam site, with inflow of average annual flow of $12m^3/s$. So, basically there will not be cutoff of water.

After the formation of the abovementioned water reduction, there will be certain impacts of the surrounding environment, for instance the river valley landscape, vegetation growth, living of terrestrial animals and aquatic organisms (especially fishes). But the confluence of tributaries D/S of the dam will have certain mitigating roles in such impacts.

Simultaneously, after the reservoir is stored water, the flow velocity from reservoir tail to before-the-dam will gradually slow down. After the other U/S cascaded HPPs are completed, the storage and regulation roles of the cascaded HPPs will have certain impacts on hydrological regime of the river reach of Tongxingqiao HPP, especially on inflow runoff and sediment of the reservoir, etc.

③ Impacts of Daily Regulation on Hydrological Regimes D/S of the Powerhouse

When the HPP is conducting daily regulation, it will cause variation range of water level of the river reach about 42.5km D/S of the powerhouse to confluence with Nmai Hka River than the natural state. The D/S water quantity of the powerhouse will generally remain unchanged. The variation of water level will not have impact on irrigation, water supply or navigation, since Ngaw Chang Hka River does not have These functions.

6.2.1.2 Impacts on Water Temperature

There are little impacts on the water temperature during construction stage. The impacts may occur in the operation stage.

The Tongxinqiao HPP is capable of daily regulation. With reference to the formula for reservoir water temperature calculation provided in Chinese hydrological specifications, the judging formula of reservoir water temperature is as follows.

$$\alpha = \frac{\text{Average annual runoff}}{\text{Total storage capacity of reservoir}}$$

For $\alpha < 10$, the reservoir water temperature is stratified;

For $10 < \alpha < 20$, the reservoir water temperature is transitional;

For $\alpha > 20$, the reservoir water temperature is completely mixed;

For the Project, the calculated α value is 829. Therefore, stratification phenomenon will not appear of the reservoir.And there is no problem of low temperature water released of the downstream river channel.

6.2.1.3 Impacts on Water Quality

(1) Impacts during Construction Period

During the project construction period, all kinds of wastewater will be treated before discharging, which will not cause impact on the water quality in normal operation. However, in case of system accident, it may cause impacts on water quality. It is to analyze the impacts on quality of water in the most unfavorable circumstances (with the greatest amount of wastewater generated during the peak construction period, and the lowest SS content in water during the low-water season) and in case of accident.

The main sources of wastewater during the construction period of the HPP include foundation pit dewatering, wastewater from the aggregate plant and concrete batching plant, and other production wastewater, as well as domestic wastewater of the construction personnel.

① Foundation Pit Dewatering

Foundation pit dewatering includes initial drainage and regular drainage. Initial drainage of foundation pit refers to draining water stored in the foundation pit of the cofferdam, i.e., the original river water plus seepage and precipitation. The density of SS in water may increase due to filling of earth-rock cofferdam and excavation beside the bank. Regular drainage refers to draining water collected in the foundation pit due to precipitation, seepage of foundation and cofferdam and waste construction water (mainly water for curing and flushing concrete) in the course of foundation pit excavation and placing concrete of buildings. Due to foundation pit excavation and concrete placement, flushing, curing and cement grouting, the SS content in the foundation pit water will be significantly increased, and pH value will also increase simultaneously. If the wastewater directly enters mainstream of Ngaw Chang Hka River, the water quality will be affected. However, since the quantity of the foundation pit dewatering is relatively small, and the river water has strong diluting effects on the SS content, foundation pit dewatering will have insignificant impacts on water quality of Ngaw Chang Hka River.

② Wastewater of Artificial Aggregate Plant

It is to totally arrange three artificial aggregate plants in the project. The production capacity of headwork aggregate plant will be 210t/h, with water consumption of 150m^3/h and recovery rate of 100%; the production capacity of powerhouse coarse aggregate plant will be 80t/h, with water consumption of 70m^3/h, and the recovery rate of 100%; the production capacity of Nam Maw River fine aggregate plant will be 100t/h, with water consumption of 70m^3/h, and

the recovery rate of 100%. According to monitoring results of similar projects, its pollutant will mainly be SS, and the emission density can be as high as 20,000mg/L and more. Since no wastewater will be discharged, it will basically not have any impact on water quality.

③Wastewater of Concrete Batching Plant.

It is arranged 5 concrete production devices for the Project, including concrete production system for head structure and concrete production system for powerhouse; 3 simple concrete mixing stations are also set at 1#, 2# and 3# construction adits of diversion tunnel. The production wastewater generated by the three concrete batching plants will mainly come from flushing the concrete mixer truck, which is to be flushed three times a day, calculating by $4m^3$ each time, and discharging $12m^3$/day each system. The discharge of wastewater will be discontinuous. According to monitoring results of analogy projects, the SS concentration will be 5,000mg/L, and the pH value will be about 10~12.

④Other Production Wastewater

Concrete placement, flushing, curing and cement grouting of all the construction and production areas will also generate certain wastewater, and such wastewater will have the characteristics of multiple discharge points, low quantity, and mostly instantaneous discharge, which is suitable for simple treatment according to local conditions.

If the wastewater from the construction mechanical workshop and other wastewater likely to cause petroleum pollution are discharged into the surface water without treatment, it will form a layer of oil membrane on the surface of the water body, and cause certain impacts on aquatic organisms.

⑤Domestic Wastewater

The master construction programme of the project will be 45 months, the average number of construction personnel will be 1,500, and the number of construction personnel during the peak construction period will be 1,950.The domestic wastewater volume to be generated is to be calculated by $0.1m^3$/capita•d, then the domestic wastewater discharge during the peak construction period will be $195m^3$/d, and the total domestic wastewater to be generated during the construction period will be $20.92\times10^4m^3$. The nature of domestic wastewater in the construction area will be similar to the urban domestic wastewater, and the main pollutants will be COD_{Cr}, BOD_5, SS, TP and TN, in which the concentration of COD_{Cr} and BOD_5 will be about 400mg/L and 200mg/L respectively.

The discharge of wastewater during the construction period will be substantially different in comparison with the inflow of Ngaw Chang Hka River (with great runoff-wastewater ratio), therefore, discharge of construction wastewater will not have significant impacts on water quality of Ngaw Chang Hka River.

(2) Impacts during Operation Period

Once Tongxinqiao HPP is completed, the formed reservoir will be a channel reservoir, the reservoir capacity will be insignificant. The reservoir will have daily regulating capacity only, and reservoir water will exchange frequently. Moreover, the water quality status of the river reach of the project area is relatively good. Therefore, the possibility of eutrophication in the reservoir will be limited. However, at the early stage of reservoir storage, due to decomposition of the residual organic substances at the bottom of the reservoir, a lot of nutrients like nitrogen and phosphate in the soil will enter the reservoir, which will be favorable to accumulation of these pollutants in the reservoir, and cause the density of water pollutants in the reservoir to rise within a certain period of time, especially nitrogen and phosphate. However, with the operation of the reservoir, the pollutants of the reservoir will also be discharged with the flows.

6.2.2 Impacts on Biological Environment

6.2.2.1 Impacts on Aquatic Organisms

Once the HPP is completed, the flow velocity will slow down, sediment will settle, water body transparency will improve, the nutrients in the soil of the submerged area will seep out, the organic matters and minerals in water will increase, and such changes will be good for growth and reproduction of planktons. Since water body exchanges are quite frequent, it is estimated that the phytoplankton biomasses of the reservoir area will somewhat increase after the reservoir is built, but by limited margins, which will eventually stabilize at a level slightly higher than the original river channel, and its composition of species will be basically the same as that of the original river channel. Then the biomass of zooplanktons feeding on phytoplankton will increase accordingly, and its trend of changes will be similar to that of phytoplankton. With the enlargement of slow-flowing water area in the reservoir area and increase of primary productive force, biomass of benthic animals will increase accordingly, but the increased quantity will not be significant. As to sessile organisms and periphyton, since water flow will slow down, water depth will be increased and impacts of sediment silting, its biomass may be somewhat reduced, especially at the reservoir tail and before the

dam. However, in the waters near the banks, since there are appropriate conditions of light, water depth, flow velocity and nutrients, sessile organisms and periphytons will still be quite advantageous. The number of aquatic vascular plants in the reservoir area is limited. After the HPP is put into operation, some waterweeds will emerge in the reservoir bay, but due to such reasons as reservoir level changes and the most reservoir bank being rocks, the increase of aquatic senior plants is estimated to be very limited.

When the HPP generates power with diverted water, there will be about 14.7km water reduction and dewatering river reach between the dam and the powerhouse. Some of the sessile organisms and periphyton in this river reach will be dried to death, biomass of phytoplankton and zooplanktons will also decrease. The species, composition and biomass of aquatic organisms on mainstream Ngaw Chang Hka River D/S of the powerhouse will be basically the same as the natural river reach.

In general, after the HPP is completed and put into operation, with the change of habitat conditions, it is estimated that the primary productive force in the entire reservoir will be improved, food organisms will be slightly increased than those before the reservoir is built.Planktons will become a main component of food organisms in the reservoir. The composition and abundance of aquatic organisms between the dam and the powerhouse will significantly decrease, and the aquatic organisms on mainstream Ngaw Chang Hka River D/S of the powerhouse will basically maintain the original state.

6.2.2.2 Impacts on the Fish

Due to hindrance of the dam, the sphere of activity of the fishes will be limited.

In comparison with the natural conditions, the area of waters will increase (submerging land), and water level before dam will rise after the reservoir is completed. The areas, depths and body of the water will increase, DO in water body will be somewhat lower, which will be unfavorable for indigenous fishes that need environment with high content of DO. The flow velocity will slow down, sediment will settle, water body transparency will improve, and primary productive force will increase， and the number of organisms suitable for slow-flow environment will increase, while those suitable for torrent environment will reduce, . The original torrent open aquatic ecosystem within the reservoir area will change to valley channel reservoir ecosystem. Changes of hydrological conditions in the river reach of the reservoir area will result in changes to fish habitat conditions and reproduction conditions. The improvement of primary productive forces of water body and the changes of food organisms

will directly and indirectly affect the composition of fish species and its biomass in the river reach of the reservoir area. Overall, the biomass of fishes adaptive to sluggish water or still water will increase, and become the dominant species.

In the water-reducing river reach between the dam and the powerhouse, the quantities of resources of fishes will decrease, no matter they are adaptive to torrent environment or slow-flow environment.

6.2.2.3 Impacts on Terrestrial ecology

(1) Impacts on the biodiversity

The project construction impacts on the biodiversity can be divided 3 parts. They inundated area, construction area and around area. The impacts is changing with the period.

1) The preparation stage, the main activity is feasibility study, there is little impacts in all area, except some individual flora are covered and dead. It is very important period, which is to do the systematic protection plan including many kinds of engineering and management measures.

2) The construction stage

   Maybe the impact is concentrated on the construction area, which is the main period. The main land occupation area is woodland, while the impacts is on the forest type. Although the biodiversity is most abundant in the forest and some areas are damaged, because it is very common style and there are many same type in this area, the whole impacts is small.

3) The operation stage

   In the initial storage period, the reservoir is filled, which the vegetation are cleared before filling. Its impact is direct in this area, but the area is limited and downstream area has the same habitat. Most importantly, there are many mitigation measures to biodiversity such as habitat protection, forbidding the cutting and hunting, reforestation and so on. After that there is little impact when it is managed well to protect.

4) The close stage

   When it is in the close stage, the dam will be demolished. All the projects is in the project area, without more new land disturbance, all the trucks and other machines are running on the original access road, which will imact little on local biodiversity, only some

temportary atmospheric and acoustic impacts in limited time. After the demolishing, the impacts will be diminishing and disappearing.

(2) Impacts on the flora

According to the indices in kind investigation data of reservoir inundation and construction land occupation, when the normal water level of Tongxinqiao HPP is 1,075m a.s.l, the total area of the construction land is 3.8km^2, including 3.67km^2 of land area and 0.13km^2 of water area; and the total inundated area is 0.306km^2, including 0.182km^2 of land area and 0.124km^2 of water area. According to land types, the reservoir will flood 16.64 hm^2 of forest land, 0.23 hm^2 of arable land (paddy field) and 13.76 hm^2 of intertidal zone and water. The phytocoenosium distributed below the flooding level of the reservoir will disappear, and it will be a permanent loss. In addition to the direct impact of reservoir inundation, construction of complex works and traffic roads, as well as construction activities will also damage local vegetation, resulting in decrease of the area of various vegetation and plant resources.

After the construction and during operation of Tongxinqiao HPP, the flow between the dam site and powerhouses will reduce compared with that in natural river courses and the water level will decrease to a certain extent. The water evaporation of the bottom of the valley will reduce, resulting in decrease in air humidity, and producing adverse impact on vegetation of valley, especially the epiphytes of tree plants. Some epiphytes will decrease with the reduction of air humidity and it is a long-term impact.

On the other hand, reservoir inundation will exert a potential and long-term positive effect on the terrestrial ecosystem on both banks along the river. The water surface is expanded after impoundment, local microclimate will change to some extent, facilitating the growth of plant and the restoration of vegetation around the reservoir.

(3) Impact on Rare, Endangered and Protected Plants

The occupied area for the project construction involves 3 plants protected by IUCN, including *Dalbergia fusca* Pierre., *Schima wallichii*, *Anisoptera scaphula*. The construction of Tongxinqiao HPP only affect some individual plants .The corresponding species will not extinct. But mitigation measures like relocation shall be taken for dalbergia fusca.

Besides, as the protected plants are widely distributed in the primeval forest, and the construction of the project and reservoir inundation will only affect a small part of the primeval forest. That is to say, it will bring a small impact on the habitats of protected species,

resulting in a little impact on the protected plants.

(4) Impact on animals

1)Impact on Mammals

According to the investigated and revised data in IUCN Red List for Endangered Animals and Wild Animals in 2009, at least 24 mammals live in the surroundings of Tongxinqiao HPP, including 5 kinds of endangered animals and 5 kinds of susceptible species.

Upon the construction completion of the HPP, the river ecosystem of the reach in reservoir area will gradually change into a lake ecosystem. As time goes by, the microclimate within the reservoir area will change to some extent, which can facilitate the growth of surrounding vegetation and the succession of community, so as to provide a better habitat for the mammals and avail the propagation of mammals. The water level and quantity of the reach between the dam and powerhouse will drop, which may affect some mammals. However, there is a number of small ditches near the river course, few animals may drink water from the main stream. therefore, it will have small impact on mammals. Furthermore, the strong migration capability of animals and whole migration of the community may also promote the communication and integration between low-altitude and high-altitude species and improve the quality of species. Besides, some individuals of some species will also be eliminated during the process of losing the original habitats and developing new habitats.

2) Impact on Birds

The impact on birds during construction of the HPP is mainly reflected in the impact on bird habitat brought by land acquisition, earth-rock excavation, operation of large machinery, blasting and so on, but such impact is only restricted to the construction area.

Once the reservoir is formed, the ecosystem in local regions will be changed, which may bring long-term interference in the birds selecting their habitats in the surrounding areas of the reservoir. However, the reservoir will also provide sufficient water for the birds in dry season, and a large area of reservoir and wetland will provide abundant food and concealed environment for those birds which like this habitat, so that the regional bird diversity may become richer.

After the HPP is put into operation, the rise of water level within the reservoir area, increase of water area and appearance of flood land will lead to the birds' migration to the areas with

higher altitude, and the quantity of species which like intertidal zone will increase to some extent.

The forming of the reservoir will influence the distribution and composition of aquatic life within the reservoir area, further affecting the distribution and composition of bird food. The change of food will have slight impact on the birds widely distributed, but it will have large impact on those birds which prey strictly, possibly resulting in the change of distribution locations of such birds.

3) Impact on Amphibians and Reptiles

In the field survey, 2 kind of amphibian and 2 kinds of reptiles were observed, none of which are protected animals. Once the construction of the HPP is completed, the original habitats will be reduced, which will influence the reptiles and amphibians. In addition, the construction of the dam will also bring certain barrier impact on the tortoises. However, in consideration of strong migration capability, they will be dispelled to the regions with higher altitude before construction and reservoir bottom cleaning; besides, the construction personnel will be prohibited from hunting the wild animals. Therefore, there will not be great impact on the reptiles and amphibians when they adapt to their new habitats. Overall, due to the movability of animals, the construction of the project only has a small impact on the reptiles and amphibians.

(5) Soil Erosion

The open excavation of earth-rock is about $133.35\times10^4m^3$, and the tunnel excavation is about $80.18\times10^4m^3$ for the project. The total amount of spoil/waste materials is about $255.96\times10^4m^3$. The project is provided with 2 stockpile and spoil disposal areas and 2 waste disposal areas, with a total capacity of about $308.28\times10^4m^3$. With reference to the characteristics of water and soil loss in earth-rock mountain regions of Yunnan Province, by calculating with the loss-to-disposal ratio of 10%, if soil and water conservation measures are not taken, water and soil loss of about 25.60×10^4 t will be caused during the construction period. Generally, volume of water and soil loss produced by stockpile area and spoil disposal area of a hydropower project accounts for 70% ~ 90% of total volume of loss within the hydraulic structure area. Therefore, it can be predicted that volume of water and soil loss produced during the project construction period is about $28.44\times10^4t \sim 36.57\times10^4t$. Project construction stage is the key period for water and soil loss control and prevention.

Although the wastes from construction are natural earth and rock without any hazardous substances, if the spoil disposal areas are not reasonably planned or the wastes are not disposed properly, the enormous amounts of wastes would adversely impact the project, land productivity, regional ecology and environment, the water quality of the Ngaw Chang Hka River, etc. The impacts mainly include:

1) Impact on the Project

If measures for soil and water conservation are not taken, large amount of wastes will be washed away into the river course and will result to river silting. It will influence the flood discharge and construction safety and decrease the regulation and storage ability of the reservoir.

2) Impact on Land Productivity

Project construction will strip a large amount of surface soil. If measures for soil and water conservation are not taken, the surface soil will be washed away by surface runoff. In addition, available nutrient and organic substances like nitrogen, phosphorus, potassium, etc. in the soil will also lose. These will impoverish the soil in the construction area, reduce land productivity, result in reduction in crop production and impact on the production and life of local residents.

3) Impact on Regional Ecosystem

Most of the vegetation with water and soil conservation function in the construction area will disappear. With the destruction of vegetation, the regional ecosystem will be affected to some extent.

4) Impact on Water Quality and Downstream Area

Water and soil loss caused by project construction will increase the sediment content of the river, as well as the pollution concentration of nitrogen, phosphorus and organic substances, and will reduce water use function. Silting up of the large amount of wastes will influence the flood discharge of the downstream river course. Besides, negative impact on water quality of the downstream water will be caused.

6.2.2.4 Impacts on the biomass

Becasuse of construction of HPP, some land are inundated as water surface, some natural area are occupied by the buildings such as dam, camp and so on. While some temportary land occupation will be recovered when project is over. According to the experience results, the

main type is woodland, with farmland and some rain forest, which the average unit biomass is 398 t/hm^2. So we calculate the total lost of biomass is nearly 1.77×10^5 t.

(1) The reservoir area

Although the biomass is lost completely in the reservoir area, it will be harvested in the process of reservoir bottom clearing. After operation, the area become the water, a kind of wetland, which is a high production ecosystem. So the impact of biomass loss in this area is small.

(2) The construction area

The construction area can be divided into the temportary and permanent area. The biomass in the former style will be recovered. The latter will be lost forever, which can't affect the whole ecosystem because of the same system is abundant in this area.

In a words, the building of project will have little impact on the biomass.

6.2.3 Impacts on Social Environmental

6.2.3.1 Impacts on Socioeconomic Impacts

The installed capacity of Tongxinqiao HPP will be 340MW, the average annual energy production will be 17.87×10^8kW•h. Once the HPP is completed, it will provide a lot of electric energy benefits and clean energy for economic development.

Moreover, project construction will need a lot of manpower and materials, which will provide opportunities for developing local construction industry, building material industry, transportation industry and other relevant industries. During the construction period, a lot of construction personnel will be mobilized to the site, which will promote production and sales of local meats, vegetables and other non-staple foodstuff. It will promote the prosperity and development of such local tertiary industries as service industry, catering industry, cultural and recreational industry, expand job opportunities for the local residents, which will not only be good for invigorating local rural economy and increasing the people's economic incomes, improving the local people's quality of life, but also strengthen the local people's awareness of commodity economy near the site, and cause far-reaching impacts on the local society and economy. Due to construction of the HPP and migration of a lot of engineers and technicians, it will bring great impacts on the local people's mentality, which will have great significance on changing the relatively isolated status, and promote social progress of the area.

6.2.3.2 Impacts on People's Health

During the construction period, the immigration of a large number of external population, the change of natural environment and the variation of living environment and facilities may lead to the rise and local prevailing of infectious diseases. For this reason, prevention and control measures must be taken for various infectious diseases, especially for intestinal infectious diseases and intestinal infectious diseases, and close monitoring should be carried out.

The increase and gathering of a large number of construction personnel in the construction area and the large personnel mobility will possibly result in susceptible population of infectious diseases and the input and output of pathogen. Therefore, the emergency handling preparation should be made for emergent public health events.

The construction of Tongxinqiao HPP will not lead to outbreak and wide spread of natural focus diseases, insect-borne infectious diseases, water-borne infectious diseases, endemic diseases, but preventive measures need to be taken actively, such as the protection of water resources, massive prophylaxis and other relevant measures.

6.2.3.3 Environmental Impacts on Resettlement

Reservoir submerging of Tongxinqiao HPP will not involve resettlement, while construction land occupation of the complex works will involve 222 people to be resettled. It is needed to upgrade and expand 18.02km of rough road and 55m of a bridge. Immigrants of the construction area of the complex works will be collectively resettled in the peripheral region before commencement of the project. Since the resettlement number is relatively low, the facilities to be upgraded and expanded are few, the environmental impacts of resettlement, related projects upgrading and expansion will be limited.

6.2.3.4 Social risk

(1)Potential impact to Population and demographic change

Potential impact of migration to the project affected area by the development of Tonxingqiao HPP Project area likely to result mainly from the migration of personnel with the hope of getting job and receiving potential health, education and other social services that may result from the project.

However, it is expected that number of personnel moving into the project affected area is very low in comparison with the existing local population. There may be no alter (less than 5 %) in

the number of residential population around the project areas or affect their demographic structure.

Thus, it is considered the potential impact related to population demographic structure of local communities is negligible.

(2)Potential impact to assess and movement

There may be traffic volume increase during the construction phase. The traffic will use Chinese Phimaw – Myanmar Phimaw to assess to the proposed project site.

Construction related traffic will utilize Local Streets which are adjuring local communities. The traffic is expected not much to interact with venerable local communities.

The impact to the public access and movement resulted from the project activities during construction and operation is forecasted minor.

(3)Potential impact to Employment, Skill and Business

Project will source it operative work forces mainly from the local area due to the reason of project's commitment of prioritizing the selection to local people and availability in adjacent areas for the basic level semi-skill and non-skilled works.

Owing to the information collected during the course of the survey in study area, the people are expecting with though that the HPP project will bring improvements to the living standard and local economic status of local people by creating job opportunities.

Since construction phase is the period of high demand of job openings with temporary employment, the numbers of employees will be dramatically high.

The prospect of an increased income and greater autonomy is likely to cause an increase in the aspirations of local communities both those involved with the project and, to a lesser extent, those from other working individually. This is a direct positive effect with a moderate extent and long-term duration. As consequence, it is considered as a major beneficial impact resulted from the project.

Developer is intending to conduct both awareness and critical training necessary to its employees, it is perceived that capacity building which is expected by both company and local community is the one of the beneficial effects as well. As this will be long term income stability to the hired employees assuring the economy security to its family members.

Both during the construction and operational phase, it has the high opportunity to employ local people in all level of full- skilled, semi-skilled, unskilled and technicians. In this regard, company shall develop local hiring plan. Here local people refer to the people living in the affected areas or entire project area of influence.

This project is anticipated to source the operative force on local basis and has the potential to increase the educational and technical qualification of local work forces through onsite technical transferring and in house training programs.

The project will definitely have significant beneficial impacts on the local communities.

One of the effective implementation of the Social Impact Management Plan of the project is the development of a capacity and local awareness building.

In order to enhance the local capacity building, and avoid unnecessary social conflict and dispute related to the employment within local communities, following measures are suggested.

Potential impact to Land Use and Property

Project is considered to be constructed and operated in the area which is belonging to government.

It is noted that there will be no resident but would be some farmland and forested land to be acquired for the proposed HPP project. Consequently, no population would be directly related to the project.

Based on the information provided above there will be some impact on the land use related issues. Mitigation measures are provided in this regards in accordance with entitlement matrix (Tables 2.4 and 5.2) as there is no serious impact on the land use and effect on the private property.

Impact on Community Value and Life Style and Social Cohesion

As mentioned early, the project area is located closed to the residential area, the temporary construction camps for workers is expected to be built in the project area which is about half kilometer to the nearest residential area.

Though a proportion of construction workforces are to be recruited from the local areas and live locally, some numbers of workforces are to be sourced outside of the community area.

It is anticipated the relationship between workforce and local community will be increased from time to time. As a result, potential crime and antisocial behavior within the local community from the Tonxingqiao HPP project are foreseeable to some extent. Those anticipated potential crimes include alcohol /drug use and other social misconducts.

The potential for increases in crime and anti-social behavior is likely and may challenge local authorities and create resentment amongst the local community. It may also result in some changes to the lifestyles or cohesion of communities in the surrounding suburbs.

During the phase of survey by social team, there is no significant dispute or unrest caused in terms of the political belief, religious thoughts and social concepts within the community. There is no major development in study areas and it is unlikely that social cohesion issues will arise.

Anyway, with project exist, both within and outside the current project area, this finding might alter and there could be potentially impact the project by creating a preconceived perception of the project and its associated activities from local communities and other organization.

The impact on the lifestyle and social cohesion is predicted as moderate and additional control measures are required.

Local Economy

There is some probability that the workforce will patronize local retail services, such as food outlets during lunch time, which would be beneficial to the economy at the local scale.

On the project side, it is certain that some materials required for the project use could be locally available and due to the easy accessibility, there might be greater consumption for local market and increase business opportunity for local business.

In addition, the arrival of newcomers to project area could result in increased economic activity, greater exposure to markets and opportunities, larger customer bases for local businesses and positive diversity with the community.

Community Health, safety and environmental Consideration

As complexity of prediction the impacts supposed to come out from the project, the community health and safety concentrates first and foremost the avoiding methodology of risk hierarchy.

The following key health and safety issues are identified in the project and affected area in the form of intersecting workers' health and community's health.

1. Accidents - anticipated to cause by project's vehicle movement on public road
2. Exposure to environment contaminants (i.e. dust emission, noise, water)
3. Communicable diseases such as HIV, Tuberculosis, Hepatitis.
4. Community concerns on the damage to existing environmental receptors
5. Reduced sense of community safety and security due to influx of the new comers into the project affected area
6. Public Concerns on disturbance of project on environment as it is situated in National Park
7. Public Concerns on potential fire hazard from the project

6.2.3.5 others

This project will not involve any religious or national culture facilities, mineral resources or cultural relics or historic remains, etc., and there is not negative impact in these respects.

As to the soft cultural hesitage, many external populations going into this area will take new idea, culture and so on. But the construction personnel management will be asked to amire local culture, which will guarantee protect the cultural hesitage and have little impacts on it.

6.2.4 Impacts on Atmospheric Environment

Environmental impacts on air pollution will mainly be in the construction period, during which the main construction activities affecting air quality will be dust emission of excavation, aggregate production, concrete batching, explosive blasting, domestic coal burning and vehicle transportation, etc. Moreover, vehicle tail gas and machine fuel oil waste gas will also cause certain polluting impacts to environmental air, and the main pollutants include TSP, CO, NO_2, SO_2 and CnHm, etc.

Since there is no settlement near the site, the atmospheric pollution to be generated during the construction period will mainly have significant impacts on the construction personnel, it is to be careful about labor protection of the construction personnel.

6.2.5 Impacts on Acoustic Environment

It will lead to noise pollution in the construction area because of high level noise produced by the running of mechanical equipment in construction excavation, blasting, transportation, aggregate processing, concrete mixing, etc. during the construction period, especially the peak construction period. According to the engineering machinery activities and construction intensity, and comparing with the measured value of other hydropower stations, it is forecasted that the noise source intensity is determined to be 96 dB(A) for the construction area of the main dam body, 105 dB(A) for aggregate processing system, 102 dB(A) for concrete mixing system, 130 dB(A) for blasting and 95dB (A) for quarry excavation. Therefore, the daytime noise intensity at the construction site is generally above 90dB(A). As mentioned above, there is no settlement near the construction area. Therefore, the protection objects against noise pollution in the construction period are the construction workers, for which the labor protection for them shall be strengthened.

There's no residential area at the junction between the site access and on-site access, so the impact of noise pollution in outward transport on the local residents is small.

6.2.6 Impact on the soil and sediment

(1)Impacts on the Soil

The project excavating will produce many rock and soil volume, with large amount of abandon slag. Project construction period is the key of the prevention and control of soil and water loss. According to the calculation, the total soil erosion in the construction period is about $1.37\times10^{6}m^{3}$.

Although the waste slag is natural earthwork and have no harmful substances, the large amount such as unreasonable planning dreg site or non-standard spoil will affect the project itself, land productivity, regional ecological environment and the water in Ngaw Chang Hka. Its influence mainly displays in:

(2) Impacts on the sediment

A large amount of soil rushing into the river will improve the density of sediment in the water. While the dam will block some sediment in the reservoir. The construction and operation will affect the sediment in the river, but considering the reservoir is daily regulation, the water exchange is frequent. There will not much sediment settlement. After the construction stage,

the soil erosion will be stable and less or the same as the normal statement. In the operation stage, they will form a new balance, which mean that the impact of sediment will be tiny.

6.2.7 Impacts of Solid Wastes

The total construction period of the project is 45 months. Based on the daily volume of household waste of 1kg/person, the predicated volume of daily domestic waste at the construction site is about 1.5t, and the total volume of domestic waste in the construction period reaches 2092.5t. The solid waste is of huge volume and wide distribution. Without proper disposal, the domestic waste will become the hotbed of mosquitoes and rats, which will threaten population health, and the leachate may pollute soil and underground water.

In operation period, operation and management personnel create some garbage.Considering not too much operating personnel, the amount of waste is also rare. But if it is piled up without management, human health and plant landscape will be adversely effected.

6.2.8 Impacts on Landscape

In the course of constructing Tongxinqiao HPP, it is to engage in certain intensity of hill excavation, and there will be a lot of spoil/waste materials to be piled. Although the spoil/waste materials generated are natural weathered matters without toxicity or harms, and it will not cause environmental pollution, it will occupy land, destruct vegetations and cause water loss and soil loss. While causing water loss and soil loss, part of the vegetations on both banks of the Ngaw Chang Hka River Valley will be occupied in the course of construction, which will cause impacts on natural landscape on both sides of the Ngaw Chang Hka River Valley.

6.2.9 Impacts on Geological Environment

The length of Tongxinqiao Reservoir is about 2,65km. The river valley of the reservoir area is relatively narrow, being V-shaped, which is topographically steep. The topographic gradient is generally 35° ~45° , locally being steep cliff, and bedrocks are mostly exposed. The reservoir basin bedrock is mainly Yanshanian grayish white medium ~ coarse-grained adamellite monzonitic granite. The bedrocks on L/B of the reservoir area are mainly weakly weathered rock masses, while the bedrocks outcropped beside R/B of the river are mainly weakly weathered rock masses. There is no large landslide or collapse masses found in the reservoir area.

The reservoir basin bedrock is with good closure conditions. The underground water divides on both banks are higher than FSL, without the issue of reservoir water seeping toward low-lying valleys. The mountains on both banks are thick, mostly outcropped with bedrocks, and the overall stability conditions of reservoir banks are relatively good. Slopes on both banks of the reservoir area are relatively steep and without the issue of immersion.

The river valley is basically symmetric, both banks are topographically integral.The L/B is the ridge between the Ngaw Chang Hka River and Pailai River, with relatively good vegetation.T he topographic gradient is generally 35° ~45° , locally being steep cliff, and about 10m above the river surface is a steep cliff . The mountains on the R/B are thick and with relatively good vegetations.The topographic gradient is 30° ~40° .

Weathering of the R/B of the dam site is slightly stronger than that of the L/B, it is estimated that a regional fault (Gudong – Tengcheong Fault) passes the U/S of the dam site area, but the structural trace is unobvious and without significant impacts on the complex structures.

6.2.10 Impacts of Floods

(1) Impacts during the Construction Period

During the construction period, it is to retain water by the cofferdam by stage diversion mode. And it is to discharge flood by different combinations of the diversion tunnel, dam gap and flushing bottom outlet, under the design flood standard of discharge in 10-year recurrence period.

(2) Impacts during Operation Period

1) Impacts of flood on the dam

While damming up the river, the dam also must be able to guarantee its own stability under the effects of water pressure. The height of concrete gravity dam in this project is 63m According to relevant Chinese standards and codes, the dam is a Grade 2 structure. Correspondingly, the recurrence period of design flood is 100-year with a peak discharge of 2,300m^3/s, the design flood level of the reservoir is El.1,071.84m and the D/S water level is El.1,045.69m, while the recurrence period of check flood is 1,000-year with a peak discharge of 3,090m^3/s, the check flood level is El.1,076.19m and the D/S water level is El.1,048.05m. In order to maintain the stability of dam body under design flood level, the dam must have sufficient stable cross section. According to the calculations of dam stability and stress, the

D/S slope ratio of the dam is 1:0.7. See table 6.2.9, the calculation results indicates that under basic combination and occasional combination, the antislide stability resistance effects of dam body are all higher than slide action effects; and no tensile stress is generated at dam heel, all the vertical normal stress exert on the dam foundation are compressive, the dam has no probability of slide or overturn under the above mentioned flood standard.

Main points of the dam stability and stress calculation are sumarized as following table.

Table 6.2-1 Summary of the dam stability and stress calculation

❶ Basic Mechanical Data

As above mentioned in section 5.3.3, Rock masses of the dam foundation are mostly of Class II.Based on the series of physical-mechanical tests carried out at the feasibility study phase, the basic mechanical data assumed for the calculation is as follows:

shear-resistant friction factor of dam foundation f′=1.15;

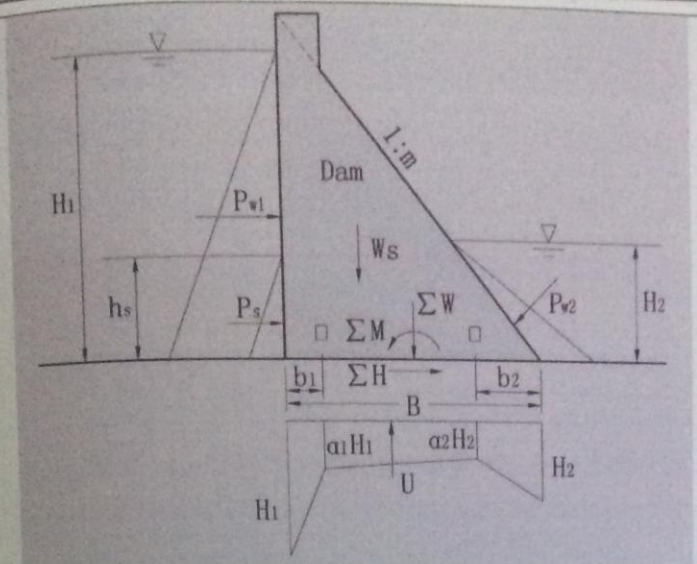
shear-resistant cohesive force of dam foundation c′=1.05MPa;

allowable load-bearing capacity of bedrock is 4.0~5.0MPa.

❷ Calculating Conditions and Load Combination

Loads / Conditions	Loads & combination				
	Self weight	Upstream hydrostatic pressure	Downstream hydrostatic pressure	Uplift pressure on the bottom	Sediment pressure
Basic work condition under the normal water level	√	√ Waterlevel: 1,075.00m	√ Waterlevel: 1,027.00m	√	√ Sediment elevation:1,041.00m
Occasional work condition under the check flood level	√	√ Waterlevel: 1,076.19m	√ Waterlevel: 1,048.05m	√	√ Sediment elevation:1,041.00m

❸ Load Calculating

Diagram of calculation		
Loads	Calculating Fomula	Parameter Specification
Self weight	$Ws = \gamma_c \cdot A \cdot unitL$	$\gamma_c = 24{,}000N \cdot m^{-3}$
Hydrostatic pressure (upstream)	$Pw1 = 0.5\gamma_w \cdot H_1^2 \cdot unitL$	$\gamma_w = 9810N \cdot m^{-3}$
Hydrostatic pressure (Downstream)	$Pw2 = 0.5\gamma_w \cdot H_2^2 \cdot \sqrt{1+m^2} \cdot unitL$	$\gamma_w = 9810N \cdot m^{-3}$
Uplift pressure	$U = U_1 + U_2 + U_3$ $U_1 = \gamma_w \cdot \frac{1+\alpha_1}{2} \cdot H_1 \cdot b_1 \cdot unitL$ $U_2 = \gamma_w \cdot \frac{\alpha_1 H_1 + \alpha_2 H_2}{2} \cdot (B - b_1 - b_2) \cdot un$ $U_3 = \gamma_w \cdot \frac{1+\alpha_2}{2} \cdot H_2 \cdot b_2 \cdot unitL$	$\alpha_1 = 0.25$, $\alpha_2 = 0.5$
Sediment pressure	$Ps = 0.5\gamma_s' \cdot h_s^2 \cdot tg^2\left(45° - \frac{\varphi_s}{2}\right) \cdot unitL$	$\gamma_s' = 9600N \cdot m^{-3}$ $\varphi_s = 24°$

❹ Stability Analysis

Work conditions	Sliding Stability FS	Overturning Stability FS
Basic work condition under the normal water level	4.32	1.93
Occasional work condition under the check flood level	5.29	1.84
	$\frac{f' \times \sum W + c' \times B \times unitL}{\sum H}$	$\frac{\sum M_{anti-overturning}}{\sum M_{overturning}}$

❺ Stress Analysis

Work conditions	Vertical stress on upstream side	Vertical stress on downstream side
Basic work condition under the normal water level	0.23MPa	1.07MPa
Occasional work condition under the check flood level	0.35MPa	0.82MPa
	$\frac{\sum W}{B \cdot unitL} + \frac{6\sum M}{B^2 \cdot unitL}$	$\frac{\sum W}{B \cdot unitL} - \frac{6\sum M}{B^2 \cdot unitL}$

2) Scouring to the D/S river bank

Since construction of the dam will heighten the water level of the river, the flow velocity through the water releasing orifices will greatly exceed the natural status. That may cause serious scouring to the D/S river course, and even bring about unstability of the D/S river banks, mainly depends on the mean waterhead of the flow and antiscouring condition of the D/S river course.

In particular, the reservoir FSL of Tongxinqiao HPP. is El.1,075m, the maximum backwater height is about 45m, in comparison with the lowest water level of the original river channel. Under the condition of design and check flood level, the mean waterhead of the releasing flow is 26.15m and 28.14m respectively, Which is particularly limit among many other hydropower projects.

Furthermore, the geologic condition of the downstream river bank in this project is pretty good, with strong antiscouring ability and well stability, see figure 6.2.9-2.

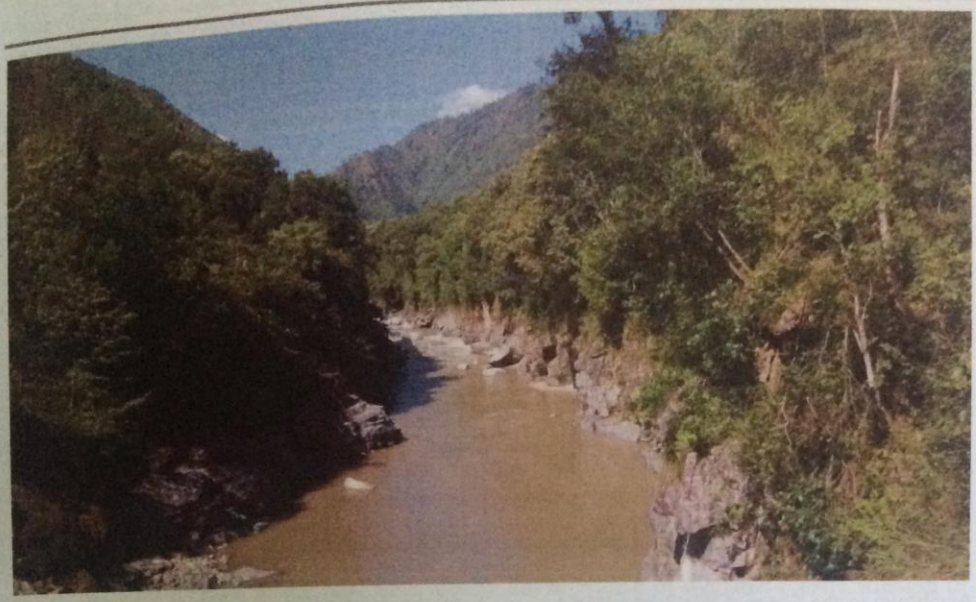


Figure 6.2-1 Natural Geologic Condition of the D/S River Bank

In light of the analysis about the above two aspects, the scouring problem of D/S river bank will be not serious and can be easily solved.

3) Flood control of the powerhouse area

The powerhouse of Tongxinqiao HPP. is to be arranged on the ground. According to the industrial specifications of China, the powerhouse will be a Grade 2 structure. Correspondingly, the design flood recurrence period is 100 years with a peak discharge of 2,460 m^3/s and water level in the D/S river channel of El. 789.15m, while the check flood recurrence period is 500 years with a peak discharge of 3,060 m^3/s and D/S water level of El. 790.05m.

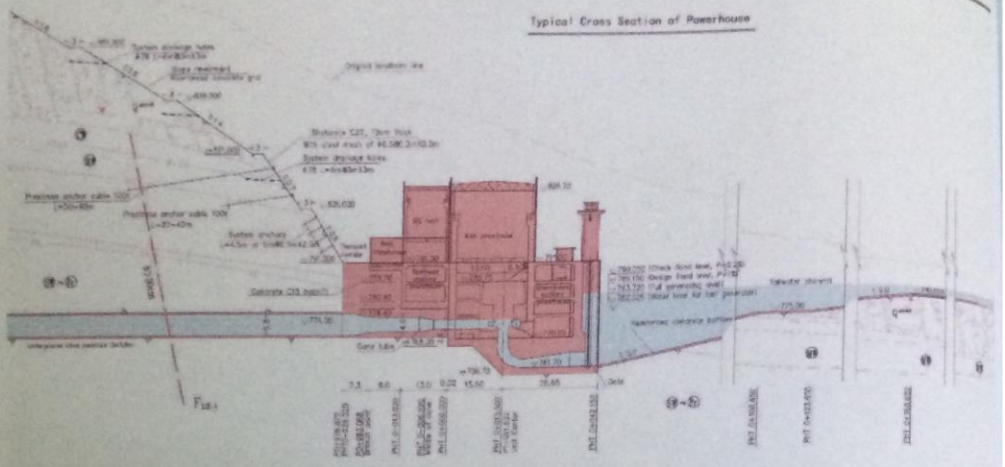


Figure 6.2-2 Cross Section of Powerhouse

As shown in the figure 6.2.9-3, the flood control elevation of the powerhouse is arranged at El. 791.00m, considering certain free board. Therefore, flood with recurrence period less than the above design standard will basically not cause impacts on the safety of the powerhouse

6.2.11 Impacts of Earthquake

According to conclusions of seismic safety evaluation, seismic activities are frequent within the project site. The peak ground acceleration of bedrock at 10% probability of exceedance in 50 years in the dam site and the powerhouse site is respectively 0.18g and 0.21g.The basic seismic intensity of the site is Mag. VIII, which is a high seismic intensity area.

Referring to relevant Chinese technical standards and codes, the grade of such main structures as concrete gravity dam and headrace/power generation structures is Grade 2. The seismic protection class of the concrete gravity dam is Class B, and that of headrace/power generation structure is Class C, while the seismic protection intensity of the main structures are adopted as the basic intensity of Mag. VIII.

In combination with analysis about the geologic conditions, complex layout schemes and structure types of Tongxinqiao HPP, earthquake impacts on the project are mainly manifested in the following aspects:

(1) Impacts of earthquake on dam safety

With a crest elevation of El. 1,078m and the maximum dam height of 63m, the gravity dam of the project has a total crest length of 173m. The basic profile of the dam is triangle, while the

D/S slope ratio is 1:0.7.

The bedrock lithology of the dam site is medium-coarse grained granite of Yanshanian period (γ53), which is mainly hard rocks of Class II with high rock strength, good integrity and homogeneity. Without moderately or gently dip fault outcropped, both the strength and stability of bedrock can meet the requirements for building a 63m-dam, with no risks of excessive deformation or uneven settlement under earthquake.

Shown as table 6.2.10, calculations had been carried out to review the stability and stress of dam body under the above seismic acceleration, while the seismic load is considered with quasi-static method. The results shown that: due to impacts of seismic load, the antislide safety of the dam along the foundation is somewhat reduced than the normal operation conditions, but the ratio of resistance effect to action effect is still over 1.0; there is tensile stress less than 0.1MPa at the dam heel, below the tolerance of dynamic tensile strength of dam concrete; although the compressive stress of the dam toe of the D/S face is somewhat increased, yet less than the compressive strength of bedrock and concrete, with relatively great safety margin.

In general, even under the designed seismic condition, the stability and stress of the dam are still uder the limits of industrial standards, and will have no possibility of holistic sliding instability or fracture overturning.

Table 6.2-2 Summary of the dam stability and stress calculation under earthquake

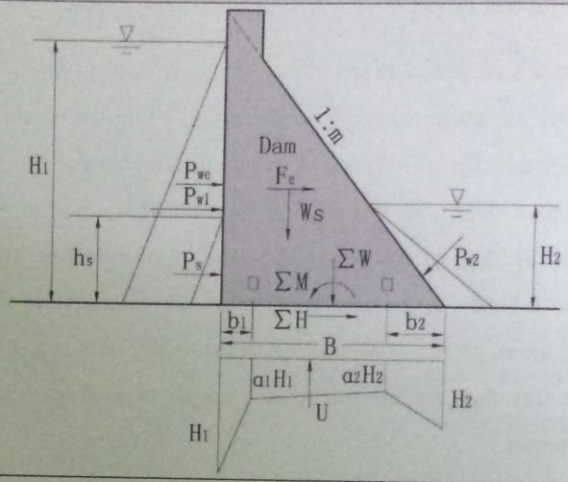
❶ Basic Mechanical Data
As above mentioned in section 5.3.3, Rock masses of the dam foundation are mostly of Class II.Based on the series of physical-mechanical tests carried out at the feasibility study phase, the basic mechanical data assumed for the calculation is as follows: shear-resistant friction factor of dam foundation f′=1.15; shear-resistant cohesive force of dam foundation c′=1.05MPa; allowable load-bearing capacity of bedrock is 4.0~5.0MPa.

❷ Load Combination						
Self	Upstream	Downstream	Earthquake	Upstream	Uplift	Sediment

weight	Hydrostatic pressure	Hydrostatic pressure	Inertia Force	Hydrodynamic pressure	pressure on the bottom	pressure on the upstream surface
√	√ Waterlevel: 1,075.00m	√ Waterlevel: 1,027.00m	√	√	√	√ Sediment elevation: 1,041.00m

❸ Load Calculating

Diagram of calculation



Loads	Calculating Fomula	Parameter Specification
Earthquake Inertia Force	$Fe = a_h \cdot \xi \cdot \Sigma(G_i \cdot \alpha_i)/g$, $\alpha_i = 1.4\dfrac{1+4(h_i/H)^4}{1+4\sum_1^n \dfrac{G_{Ej}}{G_E}(h_j/H)^4}$	$a_h = 0.18g$
Hydrodynamic pressure (upstream)	$Pwe = 0.65a_h \cdot \xi \cdot \gamma_w \cdot H_1^2/g$	$a_h = 0.18g$

❹ Stability Analysis

Sliding Stability FS	Overturning Stability FS
3.69	1.64
$\dfrac{f' \times \sum W + c' \times B \times unitL}{\sum H}$	$\dfrac{\sum M_{anti-overturning}}{\sum M_{overturning}}$

❺ Stress Analysis

Vertical stress on upstream side	Vertical stress on downstream side
-0.06MPa	1.36MPa
$\dfrac{\sum W}{B \cdot unitL} + \dfrac{6\sum M}{B^2 \cdot unitL}$	$\dfrac{\sum W}{B \cdot unitL} - \dfrac{6\sum M}{B^2 \cdot unitL}$

(2) Impacts of earthquake on ground powerhouse

The net width, length and height of the main powerhouse is 20m×45m×51m respectively. The elevation of generator floor is El. 785.70m, while that of turbines is El. 774.00m. The erection bay is arranged at the left end of the main powerhouse, with net width of 20m. Auxiliary powerhouses are to be arranged on the U/S and D/S sides of the main powerhouse respectively. The bottom of the draft tubes are at El. 761.70m.

As prospecting results exposed: the bedrock of powerhouse is mainly slightly weathered with good integrity and high bearing capacity and good stability, and will not generate relatively large deformation or uneven settlement under seismic condition.

Moreover, the lower part of the powerhouse is characterized as mass concrete structure, with relatively large gravity, and with no possibility for instability or overturning under earthquake. However, the superstructure of the powerhouse may generate relatively great internal force and displacement under seismic conditions. Therefore, the key to protection against earthquake for the powerhouse, is to conduct aseismic design to the superstructure of the powerhouse (such as roof), so as to prevent collapse.

(3) Impacts of earthquake on reservoir bank

The reservior FSL of Tongxinqiao HPP is El.1,075m, with the maximum backwater depth of 45m and backwater length about 2.65km. The normal storage capacity of the project is only about $5.14\times10^{6}m^{3}$.

Through investigation, the geologic structure is undeveloped, without development of such unfavorable physical-geologic phenomenon as relatively large landslide. Both banks near the FSL are mostly rocky bank slopes, with relatively small overburden thickness and relatively good stability. In view of the above, the reservoir bank has no potential of large scope instability and surges threatening dam safety under the seismic conditions.

(4) Impacts of earthquake on excavated slopes of structures

The excavated slopes of the main structures in Tongxinqiao HPP include slopes on both banks of dam abutment and slope after the powerhouse. The maximum slope height are basically between 70~80m, limited in general. Slopes on both banks of the dam abutment are rocky with good stability. The middle and upper parts of the slope after the powerhouse are multi-cause deposits, with relatively poor stability.

According to the geologic conditions exposed by excavation, it is planned to adopt system shotcreting&rock bolting support and drainage measures or deep prestressed anchoring measures, so as to ensure the slope's stability under earthquake.

6.2.12 Impact on Climate change

As we have discussed nearly all sides of environmental impact, the residual impacts is mainly on the climate change, greenhouse gas emission and so on.

Hydropower is a renewable, efficient, and reliable source of energy that does not directly emit greenhouse gases or other air pollutants, and that can be scheduled to produce power as needed, depending on water availability

Hydropower is a clean source of energy, as it burns no fuel and does not produce greenhouse gas emissions, other pollutants, or wastes associated with fossil fuels or nuclear power. However, hydropower does cause indirect GHG emissions, mainly during the construction and flooding of the reservoirs. This may be due to decomposition of a fraction of the flooded biomass and an increase in the aquatic wildlife and vegetation in the reservoir. Hydropower's GHG emissions factor (4 to 18 grams CO_2 equivalent per kilowatt-hour) is 36 to 167 times lower than the emissions produced by electricity generation from fossil fuels. Compared to other renewables, on a lifecycle basis hydropower releases fewer GHG emissions than electricity generation from biomass and solar and about the same as emissions from wind, nuclear, and geothermal plants. With the 4 grams/kw multiplying the totol energy per year, it is approximately reducing the GHG emission 678 t/a at least.

Hydropower is mainly criticized for its negative environmental impacts on local ecosystems and habitats. Damming a river alters its natural flow regime and temperature, which in turn changes the aquatic habitat. Such a change disturbs the river's natural flora and fauna. Fish are very sensitive to hydropower operations, and fish species (especially migratory species) have been significantly affected by hydropower dams. But small, low and micro hydropower facilities such as Ngaw Chang Hka cascades have much smaller negative environmental impacts than large hydropower facilities, but even they can engender public concern.

Studies have estimated significant potential for increased deployment of hydropower, with additional generation capacity, mostly provided through the development of new small and micro hydroelectric plants, development of new hydroelectric capacity at existing dams without hydropower facilities, and generation efficiency improvements at existing facilities.

Fully realizing the aforementioned low or high estimates of new hydropower potential might reduce or avoid CO_2 emissions.

Hydropower is one of the least expensive sources of power since the cost of hydropower is dominated by the initial capital cost of building the facility while the ongoing operating and maintenance (variable) costs are low. Moreover, since hydropower generation does not require burning fuels, operations costs are not vulnerable to fuel price fluctuations. Hydropower facilities are very cheap to operate and they can operate for 50 years or more without major replacement.

In all, the greenhouse gas, carbon storage and climate change impact from the hydropower project will be happen in the initial period. With the progressing of the project, the positive impacts are more and more dominated than the negative impacts. The whole impacts of GHG emission, carbon storage and climate change is positive. So, except the mitigation measures of the vegetation recovery in construction phase and some management measures in the operation phase, which is belonging to the ecological mitigation measures at the same time, there will be no need to other measures.

6.2.13 Residual impacts

The residual impacts express the impacts after the construction, which mainly include solid waste and workyard impacts. It will be analysed from different environmental factors. As to the significance of imacts, its sequence is solid waste impacts, water impacts, air and noise impacts ecological impacts, successively.

(1)The solid waste impacts

The oddments is mainly the concrete waste, soil and rocks, metal waste, domestic waste and so on. they will be collected and transported to the spoil disposal area. So it will not affect the landscape, ecology around the workyard. The useful waste will be reused and the left will be thrown to the spoil area.

(2) Water environmental impacts

The quality of surface water will not be affected by the project except some sedimenting some dust and chippings, which will make the suspended solid increase in the water. But it is temprotary. The impacts are small to the water.

(3)Acoustic and air impacts

The noise and air mainly come from the bulldozers, trucks and traffics. Analogied with similar projects, the noise value is nearly 92 dB(A). The traffic noise is about 80 dB(A) from transporting the slag. Because the workyard is far away from the housing estate, the noise only affects the fauna such as birds and other terrestrial animals. It will disappear with the close of the cleaning. The air impacts are mainly from dust and vehicle exhaust. With the water spraying measure and good situation of vehicles, the impacts will be small and over after completion of workyard clearing.

(4) Ecological impacts

Without extra new land occupation, there is no more impacts on the ecology. It mainly includes the atmospheric and acoustic impacts, which will impact the surroundings. It will disappear after the cleaning of the workyard.

6.2.14 Impacts to the several constrution site

(1) Impacts on the headrace tunnel

1) Discharging impacts

The headrace tunnel is long and the discharging exits are distributed at the adits exits, with features of many points, scattered and a great deal of waste water. According to the similar experience, the main material in water is SS, with the concentration of 102mg/L, which will not pollute the surface water. It will be discharged to the river directly. So the impacts will be little to the environment.

2) Impacts on the groundwater

The underground water impacts mainly involve its quantity. The quantity relects that a great deal of water flows into the surface water in the construction period. When the headrace tunnel is completed, the tunnel will be sealed and the underground water will not dicharge. The underground water will never be impacted.

3) Impacts on the ecosystem

The impacts can be expressed from 2 side. One is to the species and the other is to the vegetation.

a. Impacts on the species

There are a great deal of species living along the headrace tunnel. To the flora, because the

groundwater is buried deep, the water the flora needs is the natual precipitaion and surface water. Some plants are killed by the land occupation, with which common plants and a few area are impacts. So the flora doesn't matter with the tunnel building. But to the fauna, the construction may affect the daily life near the adit exits. But it limited the adit area and construction period. After the construction, the impacts will disappear.

b.Impacts to the vegetation

The adit construction will cover some vegetation, which is mainly involved the access road, construction factories. The construction area is small and the similar vegetation is common the area. So the impacts to vegetation is small.

(2) Impacts on the quarry, concrete fatory and concrete maker factory

The impacts on the construction of quarry, concrete factories and concrete maker factories include the ecological impacts, water and soil erosion, noise impacts and dust impacts. The impact from the quarry is covering the vegetation, blasting, breaking and loading noise. The concrete maker facorties affect the water quality and noise. The concrete factories mainly have many impacts on the noise and air. All the details have been described on the different environmental factors at different paragraph.

6.3 Mitigation Measures

6.3.1 Mitigation Measures for Water Environment

(1) Treatment of Wastewater From Aggregate Processing System

As mentioned above ,this Project is provided with 3 aggregate processing systems. Waste water discharge amount of the aggregate processing systems is large, accounting for about 90% of all production waste water discharge amount. Major pollutant is suspended substance, excluding organic pollutant and hazardous substances. According to the settlement property of the suspended substance, coagulant sedimentation method is adopted for settlement.The sediment will be cleaned irregularly, and the cleaning water will be recycled or discharged. The three aggregate plants in the project are respectively provided with one coagulation sedimentation tank for treatment of flushing waste water, with treatment capacity of $200m^3/h$(headwork aggregate plant), $100m^3/h$(powerhouse aggregate plant) and $200m^3/h$ (Nam Maw River aggregate plant) respectively.

There is no waste water discharge, due to the application of a package system in the aggregate

processing system for waste water treatement. The process chart of treatment and recycling of the waste water from aggregate processing system is shown in Figure 6.3-1.

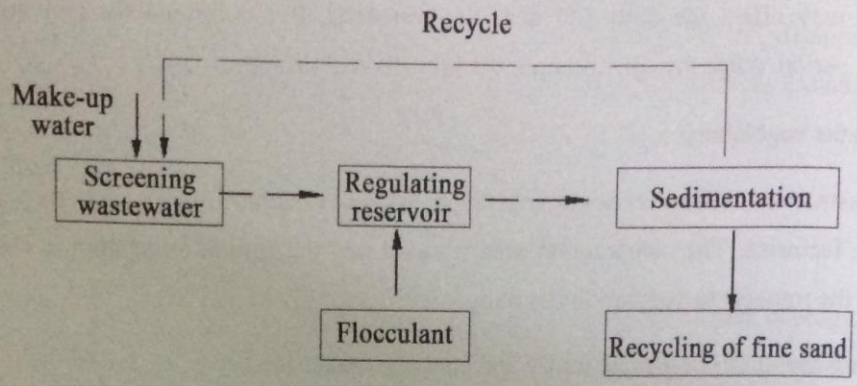


Figure 6.3-1 Chart of Treatment and Recycling of Wastewater from Aggregate Processing

(2) Treatment of Wastewater from Concrete Processing System

It is arranged 5 concrete production devices for the Project, including concrete production system for head structure and concrete production system for powerhouse; 3 simple concrete mixing stations are also set at 1#, 2# and 3# construction adits of diversion tunnel.

The concrete mixing systems adopt simple sedimentation and neutralization methods to treat the wastewater. The wastewater flows automatically into the sedimentation tank where the sediment in the wastewater settles. Flocculant can be dosed if necessary. Clean water through sedimentation will be recycled or discharged after neutralization. Sludge will be transported to dreg site.

The wastewater treatment process of concrete processing system is shown in figure 6.3-2. As the concrete flushing wastewater treatment is simple in structure and has no issue on machinery maintenance, attention shall be mainly paid to regular cleaning in operation. Management work shall be included into the unified arrangement of concrete mixing system, and no separate arrangement will be made for the machinery and operation personnel.

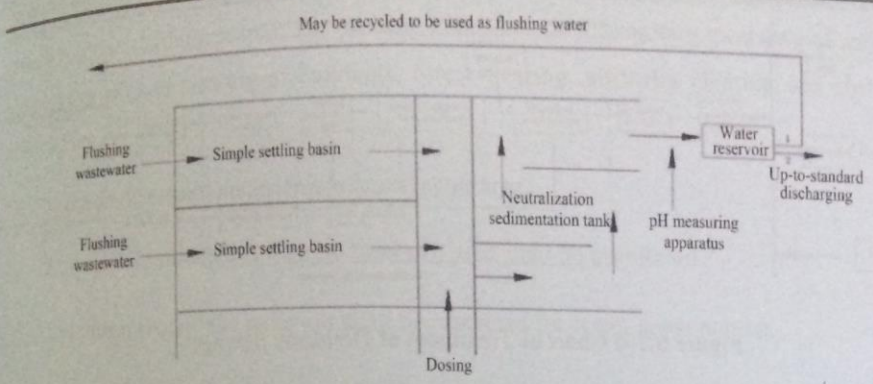


Figure 6.3-2 Chart of Wastewater Treatment Process of Concrete Processing System

(3) Wastewater from Equipment Repairing and Automobile Maintenance System

The package equipment is generally employed in large sized hydropower projects to treat waste water from equipment repair workshop and automobile repair and maintenance workshop. The sewage treated is discharged up to standard. Refer to Figure6.3-3 for process flow chart of oily sewage treatment.

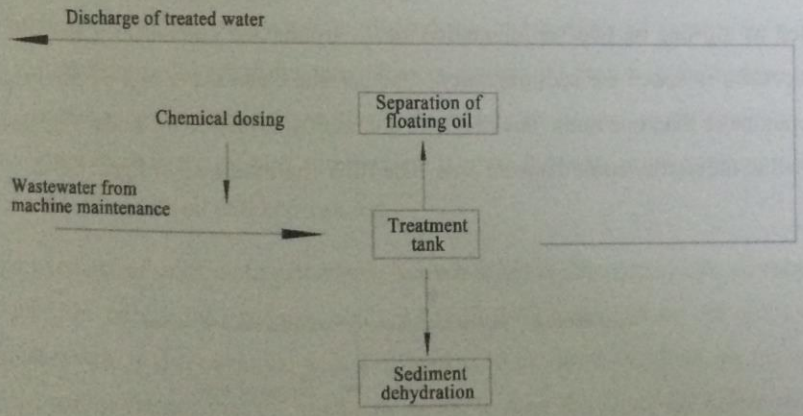


Figure 6.3-3 Chart of Oily Sewage Treatment Process

(4) Treatment of Domestic Sewage in Construction Area

It is recommended to use buried package domestic sewage equipment to treat domestic sewage from each living camp of Tongxinqiao HPP. The treated sewage shall be discharged or used as the landscaping and greening water, referred to Figure6.3-4 for treatment process flow. There are three camps and the treatment capacity of each camp is $80m^3/d$.

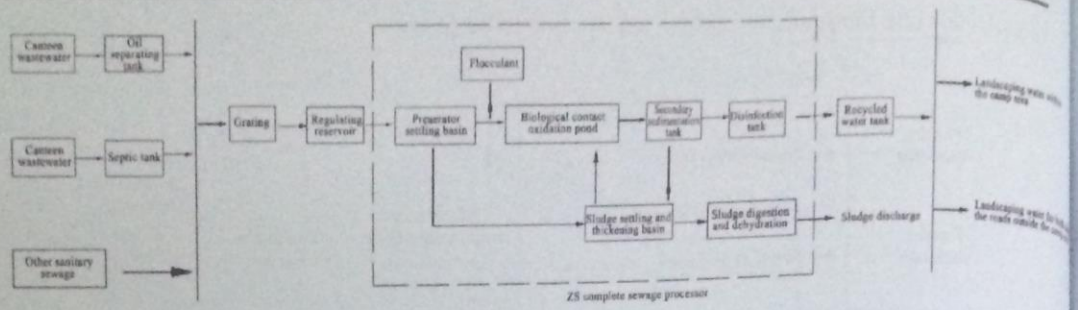


Figure 6.3-4 Chart of Treatment of Domestic Sewage

(5) Tunnel discharging wastewater

1) Underground water discharging

There may be underground water leakaging in the process of tunnel construction. The first measure is to block, if there are still some water flowing out, using the pump to draw clean water to the ground and discharge directly.

2) Waste water

There will be much waste water in the tunnel. In order to treat large mount of waste water, it is planned to dig one or two sedimentation basin around the enterance of the adit, adding some flocculant to speed the sedimentation. The surface clean water will be discharged after sedimenting more than one hour. The methods are mainly oxidation methods. The slag will be transported to the nearby spoil disposal area. The flow chart are seen in figure 6.3-5.

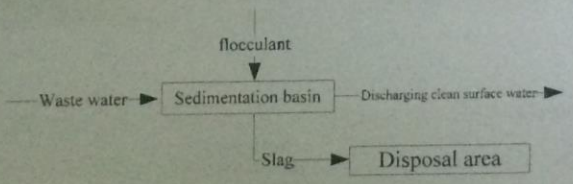


Figure 6.3-5 flow chart of the treatment of waste water from headrace tunnel

(6) Water Environment Mitigation measures During Operation Period

1) Reservoir bottom cleaning design

The scope of reservoir bottom clearing include the zones below the normal pool level of the reservoir, the line of land requisition with P=20% and the line of resident relocation with P=5%. All the houses, buildings, structures, forests, garbage and other wastes within the

clearing scope shall be cleared. The clearing items include the sanitary clearance of residential areas, removal and clearing of buildings, forest clearing, obstacles clearing and clearing of other items.

2) Water environment management in reservoir area

① Drainage of untreated sewage to reservoir area shall be prohibited.

② Vegetation around the reservoir shall be protected for water conservation.

③ Attention shall be paid to water quality monitoring to know the status of water quality in the area in time.

3) Sewage treatment and prevention during operation period

During operation period, waste water will be mainly from domestic sewage produced by permanent residents and shall not be discharged until being treated by complete domestic sewage treatment equipment already built at the Employer's camp during construction period.

4) Oil contamination prevention measures for accident oil leak

During operation period, the oil system is divided into the turbine oil system for generator units and the insulating oil system for transformers, which are stored in the turbine oil tank room and insulating oil tank room respectively. In case of explosion or oil leak accident, all waste oil is intercepted in the oil tank room which is provided with an oil retaining ridge and fire door, so that the waste oil will not leak out.

During the overhaul of units or transformers, the waste oil is discharged into corresponding slop oil tank. The turbine oil system is equipped with 2 oil tanks (35 m^3 for each) and the insulating oil system is also equipped with 2 oil tanks (30 m^3 for each). Both the two systems are provided with corresponding oil treatment rooms to treat the waste oil before recycling. The waste oil which cannot be recycled should be transported back to the oil processing plant.

In case that any accident happens to the main transformer , much oily sewage will be discharged into to public oil-bath.The waste oil treated by oil-water separator shall be recycled and the waste water shall be used for road sprinkling and greening.

6.3.2 Mitigation measures for Fishes

The dam will hinder the exchanges of fishes and other aquatic organisms U/S and D/S of the

dam. From the perspective of protecting the integrity of aquatic ecosystem of Ngaw Chang Hka River, it is to take the following measures:

From the perspective of protecting the integrity of aquatic ecosystem of Ngaw Chang Hka River, there must be some measures to conserve the fish resource. According to the field survey, there are no long distance migration fishes, and the species are common in the basin. In other side, the projects are the diversion type on the river, there are nearly 10 km from the dam to the powerhouse, it is hard or non-feasible to build engineering structures to let fish pass. We believe that the following measures are positive and effective to protect them.

(1) Fishery Administration Measures

After impoundment of the reservoir, the fish food conditions will be improved, thus the fishery yield in the reservoir area will be increased. But due to the upcoming change of the composition of fish resources in reservoir area, the population quantity of some kinds of fish originally living in reservoir area will decrease. The project also has relatively obvious impacts on the fish living in the river reaches upstream of reservoir tail and downstream of the dam. Therefore, it is suggested to improve the construction of fishery administration team, strictly execute fishery management and reduce fish catching, so as to reduce the adverse impacts.

(2) Strengthening Public Awareness of Protection

Decision makers, management personnel and scientific workers will not avoid the loss of biodiversity if they fail to obtain the support of the public. Thus, it is required to strengthen the awareness of the public on the importance of biodiversity and the initiative and ability of the public with many methods, such as publicity, education and training. Only when the public awareness is greatly improved and the decision makers obtain reliable information for making decisions, can the protection and utilization of resources be carried out continuously.

(3) Habitat protection

The HPP blocks the river to get the energy. It affects the fish. Maybe it results that it can't finish its lift history. General speaking, there are many physical methods to protected the fishes such as fish way, fish lift, catching with net and taking upstreams, habitat protection, namely tributaries protection and so on. Considering the HPP is not the big one and there are no protected fishes and migration fishes of long distance, we chose tributaries protection methods as the mitigation measures in order to save the cost and adopt more reasonable

method to protect fishes.

The habitat protection measure will be effective with the management plan, because there are similar habitats in the tributaries D/S and U/S. For example, the tributary's environmental status is the same as the mainstream.

The Chaimoka River is chosed as the protected habitat. It is at the downstream on the left bank and the river regime and other environment fators are same as the mainstream. So even the main stream is blocked by the dam, the fishes can complete the life history.

6.3.3 Measures for Protection of Terrestrial ecosystem

According to the current status and impact assessment results of ecosystem, the project construction will not cause fundamental changes to the regional vegetation types, landscape structure, diversity and stability. Therefore, the project construction will not cause serious or irretrievable ecological impacts.However, it is necessary to take proper mitigation, compensation and restoration measures for the possible impacts.

(1) Restoration of vegetations and landscape

1) The Employer should conduct environmental education and publicity education about relevant laws and regulations to the construction personnel, conduct construction in strict accordance with the designed construction range. And it is prohibited to occupy land and destruct vegetations beyond the plan. The occupied forestland and farmland should be handled procedures and compensated according to relevant rules. Once construction is completed, it is necessary to conduct vegetation restoration to the temporarily occupied land. The sections that need to be conducted vegetation restoration are mostly the areas affected by project construction, including the disposal areas, borrow pits/quarries and other construction areas.

2) Top soil storage and management for vegetation restoration

In the process of restoration, it must be mentioned that before the construction, the workyard's top soil must be collected and transported to special area and stored.when the workyard is recovered, it should be taken out and used to soil preparation. The management is responsible by the contractor, which is managed together with the spoil disposal area.

(2) Plant Diversity Protection plan

1) Publicity and Education

It is to enable the supervisors, managers and construction personnel to be clear about the types and quantities of important plants in all the sites and neighboring areas, so as to strictly conduct supervision and management in the course of construction, and reduce unnecessary destruction.

It is to conduct biodiversity conservation education, publicity and education of relevant laws and regulations to the construction personnel, and allow them to know that the ones destructing biodiversity will undertake the corresponding legal responsibilities.

2) Management of construction personnel

During the construction period, it is to formulate ecosystemal management system, prohibit construction personnel from hunting wild animals or logging trees, or carrying out activities in areas other than the construction areas through management rules and institutionalization, so as to prevent the construction personnel from damaging the plants, and mitigate the impacts of project construction on the wild plants and animals.

3) Relocation and transplanting

Once plant species in the catalogue of IUCN is encountered, it is to be taken relocation mitigation measures, and transplanted to the place where the HPP will be operated and managed.

(3) Terrestrial Animals Protection plan, especially for extinction animals such as Chinese pangolin and Dhole

The habitats of wild animals in the evaluation area are relatively diversified. In order to duly protect the habitats of wild animals and minimize the impacts of construction activities on the wild animals, it is mainly to conduct protection from the following aspects:

1) In the course of construction, it is to minimize destruction of habitats of animals, especially logging of trees.

2) In the course of construction, it is to minimize blasting to reduce intimidation of animals.

3)It is to adhere to the principle of "protection first and construction second", and it is to strictly prohibit waste materials from entering the surface water.

4) It is to prohibit pollution of water bodies by production wastewater and domestic wastewater of construction personnel, so as to guarantee that the habitats of amphibians can be free from impacts or limited impacts.

5) It is to reinforce management of construction devices. It is not allowed to let such blasting materials as explosive and detonator spread among the construction personnel and the local, which may be illegally used as tools for hunting wild animals.

6) Reduction of Light

Minimizing lighting facilities as far as possible. Use the directional lighting instead of diffused lighting

(4) Measures for Water and Soil Conservation

Retaining, diverting and drainage of water-soil conservation works have been very detailed and specific in the main work design, and it is mainly to formulate measuresfrom the aspects of plant measures and temporary measures in this report.

1) Plant measures

The disposal area is within the range of temporary land acquisition.When the spoiled material piling and useful material recovery is completed, based on protection of engineering measures, it is to level the spoil piling platform with bulldozers, restore vegetations after earthing, and adopt plant measures after trimming the spoil slope, so as to prevent water/soil loss. In order to restore vegetation, it is to select local indigenous grass seeds to spread in the concrete lattice.

Once the quarry / borrow pit is exploited, based on protection with engineering measures, it is to level the exploitation platform with bulldozers, cover with top soil and conduct vegetation restoration, and plant climbing plants (such as *Boston ivy*) for slope greening.

2) Temporary measures

Disposal area: It is to adhere to the principle of "retaining first and disposing later" for construction, i.e., it is to firstly implement the retaining facilities before piling the spoiled materials, and prevent the impacts on the D/S trenches of the disposal area in the course of piling the spoiled materials.It is to pile the spoiled materials by separate layers, and compact, and it is to conduct piling strictly according to the designed slope. For every layer piled, it is to trim the slope of the spoil piles. It is to reinforce management, and promptly clear the spoiled materials spilled.It is disallowed to load the trucks exceeding the limits. In the course of transportation, it is to cover with tarpaulin, and prevent spillage of earth and rock caused by bump.

Borrow pit / quarry area: Before stripping the borrow pits / quarries, in combination with the

construction material using time and intensity requirements, it is to formulate the standardized excavation system of borrow pit / quarry or the operation process. It is required that the stripping and exploitation time of the borrow pit / quarry shall be arranged in the dry season or days without heavy rain, so as to reduce erosion of exploited splash of borrow pit by rain, and reduce water/soil loss;In the course of construction, it is required that the Contractors shall excavate by different plots combining construction requirements and construction schedule, control the excavated slope, timely treat the excavation face to prevent its collapse.

Area of on-site transportation road: It strictly prohibited to dump spoiled materials to the road slopes and river channel during construction. Spoiled materials spilled in the course of construction shall be timely cleared, and dumped to the planned disposal areas. The temporary sporadic spoil piles and excavation faces shall be adopted temporary soil conservation measures like covering and retaining with geotextiles, etc.; It is to build intercepting ditch before excavating open pit, so as to retain the U/S inflow, and reinforce maintenance in the course of construction, so as to guarantee smooth discharge. The seeping soil or intercepting ditches subject to torrent scour shall be reinforced, to prevent seepage and scouring; It is to cover the temporary earth excavation face with geotextiles during the rainy season, and timely conduct greening or hardening treatment after completion of excavation.

Complex area: It is to try to arrange cofferdam filling and decommissioning in the low-water period, so as to reduce water/soil loss caused by erosion of running water. It is to reinforce protection and monitoring of the bank slopes D/S of the dam site, so as to prevent the scouring of released water on the bank slopes; Once the HPP is stored water and operated, it is to conduct investigation and observation about the bank slopes and geologically unfavorable areas around the reservoir, so as to find out the slope erosion and collapses, and timely work out solutions.

6.3.4 Atmospheric environment Mitigation measures

(1) Dedusting in Construction Area

1) Application of low-dust process

Those blasting processes that may generate less dust are preferred, such as chiseling blasting, pre-splitting blasting, smooth blasting and buffering blasting; It is recommended that chiseling, drilling and blasting should be carried out in moist conditions to reduce dust generation. A dust collector shall be installed for drilling.

Aggregate shall be wet crushed and screened, and dust collectors shall be equipped for pre-screening, secondary crushing, screening and sand making workshops. Bag-type dust collectors shall be equipped for the concrete mixing plant. Check the operation conditions of the bag-type dust collectors regularly to timely replace or repair them if necessary. Keep the cement tightly sealed during loading and unloading. The screw conveyor and bucket elevator shall be maintained regularly. Simple sheds shall be built for fine aggregate piles, which shall have a steady side slope, and shall be moistened appropriately to prevent from being blown away.

Enclosed slag trucks shall be employed to avoid leaking during transportation. Before leaving the construction area, any vehicle shall have its wheels and body cleaned so that no slag is carried out of the construction area to pollute the ambient environment.

2) Dedusting by water spraying

For dam and workshop areas where is excavation and blasting are highly concentrated, spray water in days without rain to accelerate settlement of dust. All major tunnels shall be provided with water-curtain dust collectors to reduce dust concentration during blasting in diversion tunnels. Underground works shall be provided with ventilation facilities to increase ventilation and reduce concentration of waste gas. Spray water in coarse crushing of aggregate and on working faces generating dust to reduce dust concentration of the work places. One sprinkler shall be provided in the project area and it shall be operated by two shifts for at least 6 times a day during the peak construction period in days without rain.

3) Waste gas of oil-fired machinery

Maintain and repair the machinery regularly. Vehicles and oil-fired facilities with large discharge capacity shall be provided with exhaust purifiers.

(2) Reduction of Traffic Exhaust and Dust

Spray water on temporary roads and clay-bound macadam for dust fall. Meanwhile, it is suggested to establish a special team for road maintenance to manage, clean and maintain the roads.

Vehicles used during construction are mostly large transport diesel vehicles, which emit more exhaust and pollutants than gasoline ones. Therefore, exhaust purifiers shall be installed to ensure that the emission can be controlled within the standard limit. Criteria of vehicle

liquidation and forced replacement and liquidation system shall be implemented. Old vehicles with engines consuming more fuel, producing excessive emissions and working in lower efficiency shall be promptly replaced.

(3) Analysis of Measure Effectiveness

By using wet blasting or low-dust blasting, together with no-dust drilling, dedusting ratio of the blasting process can be up to about 92%. Spray water timely on working faces and points for excavation, site leveling, or in slag yards for dust settlement, and spray water on road surface,is the most efficient measure to reduce dust generated in construction and transportation.

6.3.5 Acoustic Environment Mitigation measures

The principles and bases for design prevention and control measures of environmental noises are as follows: Regarding the characteristics of dispersed pollution sources of environmental noises and being hard for concentrated terminal treatment in the construction area, it is to mitigate the impacts of environmental noises from pollution sources to the sensitive points by multiple channels; Environmental mitigation measures should be combined with actual circumstances of the project, with economy, feasibility and effectiveness, and focus on treating the main pollution sources; It is to reinforce the construction management and pollution control of the project area, so that the discharge intensity of noise pollutants can meet the requirements in Thai standards customarily adopted in Myanmar.

（1） It is to select equipment, workmanship and vehicle models with low noises to lower noise source intensity.

（2） It is to reinforce maintenance of equipment and vehicles, keep the machines lubricated, and restrict overloading of vehicles and lower operation noises.

（3） It is to reasonably control traffic flows, and implement mandatory renewal and discarding system.

（4） It is to use damping seating for mechanical equipment with great vibration to reduce noise level.

（5） The aggregate screening system is to be adopted rubber network, plastic steel plate and damping materials to lower noise level.

(6) The air compressor outlet of the concrete batching plant is to be arranged with silencer, the model shall be matched with the air compressor, and the silencing amount can be as high as about 20dB.

(7) It is to reasonably arrange construction time, try to avoid construction during the night from 22:00 p.m. ~ the following 6:00 a.m.

6.3.6 Treatment of Solid Wastes

It is to follow the principle of classified treatment for solid wastes. Organic garbage and inorganic garbage in municipal solid wastes (MSW) should be treated separately to guarantee sanitation and safety; the treatment measures should be economic, effective and technically feasible, and realize reduced quantity and harmless treatment.

(1) Selection of domestic wastes treatment scheme for the construction period

In order to duly conduct environmental hygiene of living and office areas within the range of the construction area, prevent intensive reproduction of mosquitoes, flies and rats causing outburst of contagious diseases, the garbage of temporary and permanent living and office areas of the site should be timely swept and sent to designated locations for piling. To facilitate transportation, each of the L/B and the R/B are arranged with a garbage transfer station. Domestic garbage should be classified and collected as much as possible according to their natures, the recoverable ones should be recovered and used by waste recycling companies for recycling, while the irrecoverable ones should be transported from the living quarter of the powerhouse to landfill of 1# disposal area, or from other living quarters to 3# disposal area for landfill, and duly conduct anti-seepage measures

(2) Disposal of Other Wastes in the Construction Area

It is to try to reduce the quantity of wastes, which not only can reduce freights and simplify treatment workmanship, but also reduce treatment cost. The useful items in engineering wastesmay be regularly recovered and used by designated material recovery agency. Recoverable wastes include discarded construction machinery and vehicles, waste and old steel, steel pipes, oil drums, bags, timber and storage battery, etc. The leftover solid wastes without recoverable value shall be uniformly transported to 3# disposal area, and it is to duly take anti-seepage measures.

(3) Disposal of MSW during Operation Period

The permanent residents of the HPP during the operation period are not many and the amount

of MSW is not large, and it is not considered to arrange a special garbage disposal site. It is only considered to arrange 2 garbage collection stations, continue using the garbage trucks during the construction period, and regularly transport to 3# disposal area for landfill.

6.3.7 Protection of People's Health

(1) Preventive Measures

Measure for prevention and control of infectious disease is prevention first, with monitoring enhanced. Following preventive measures must be carried out against infection sources, transmission route, and susceptible population of related diseases of the Project area.

1) Sanitary measures such as disinfection, insecticide, deratization, etc. should be carried out to the living area and operation areas when the project personnel enters the construction area; potable water should be disinfected as well.

2) Purification and disinfection facilities for potable water must be ensured to provide centralized water supply for the construction area. The potable water must meet the national sanitary standard of domestic drinking water to ensure the safety of potable water.

3) Facilities such as ecological mobile toilet and sewage disposal system should be built in the construction area; waster and excrement should be disposed.

4) All patients and carriers of infectious diseases, as well as suspected patients, must not work on occupation or profession which may infect the disease.

5) Carry out vaccination or give preventive medicine to the susceptible population in a planned way according to epidemiology indication.

6) Major prevention measures must be carried out to main diseases related to the project to ensure a good sanitary protection.

(2) Crowd Management

Inundation by water storage of the reservoir, drop of water level during operation, etc. will change ecosystem and distribution scope of vectors such as murine, mosquitoes, and oncomelania. That will also change chances for human to contact with the vectors. As personnel live in centralized manner during construction, population mobility are relatively strong. Besides, puddles and sanitary blind spots will form in the construction area and provide breeding place for mosquitoes and flies, and diseases may be caused due to poor

conditions of the temporary living area, and that will absolutely affects health of the constructors and local residents. Therefore, management should be carried out for people of related areas of the project. Medical personnel of local villages and towns or village clinics should be responsible for management of surrounding population. (3) Management of Food Sanitation

The project construction will involve resettlement of local residents and immigration of large number of constructors and service personnel, thus it is easy to cause food poisoning and other acute food-borne diseases.

Sanitary clearing and inspection should be carried out regularly for public dining places. In case of food poisoning, the local health authority should be immediately informed to take emergency treatment for the patients and to control and deal with the poisonous food.

(4) Establish and Improve Medical and Health Organization

A medical organization should be set in the construction area. Necessary medical facilities, medicine and certain number of medical personnel should be provided to be responsible for treatment of common diseases, health examination, vaccination, and health publicity for constructors, and to carry out supervision and emergency treatment of infectious disease.

(5) Others

All business relating to the factory enacted law 1951 have to follow working hours, health and safety of workers and child labor confirmation.

It must have priority plan about occupational safety and health for workers.

It must have agreement between employer and employee, have to assign together with domestic, foreigner and local, should be carried out with appropriate department for workers from other countries.

6.3.8 Mitigation Measures against Earthquake Impacts

Considering the complicate seismic geologic background, importance and accident consequence of the project, it is proposed to take the following seismic mitigation measures for such key structures as dam and powerhouse, according to the requirements in relevant codes and experiences of similar projects, so as to improve the seismic resistance of the structures and mitigate the seismic impacts.

(1) Foundation treatment measures

According to the geological conditions exposed by excavation, it is to conduct concrete replacement to the locally developed weak and fractured rock masses in the range of foundation of structures, and take such measures as consolidation grouting to the parts developed with joint fissures, further improve the bedrock quality of the dam and powerhouse to ensure foundation stability. Moreover, in accordance with the actual condition, it is to arrange rock bolts or anchor piles to improve the antislide ability of dam concrete and bedrock.

(2) Structural aseismic measures

In combination with results of relevant test, research, calculation and analysis, it is planned to optimize dam geometry(such as passivating the geometry-changing parts), improve the dam concrete strength, optimize dam joint structure, improve the adaptivity of waterstop structure to deformation, adopt such structural measures as seismic reinforcement, so as to improve the seismic resistance of the dam.

For the same purpose, the thick floor slab structure will be planned for the powerhouse, so as to enhance its holistic aseismic resistanse. Meanwhile, light grid roof and reinforcement will be adopted to reduce the seismic response of the superstructure as well.

(3) Reservoir emptying measures

Once earthquake, reservoir water level can be quickly lowered through the surface and bottom releasing outlets, so as to reduce the storage quantity and water load U/S of the dam emergently, improving the stability of the dam.

(4) Safety monitoring measures

In order to ensure safety of the project, safety monitoring measures will be adopted for such sensitive structures as dam and powerhouse, and the main monitoring items include surface deformation, internal deformation, stress deformation, temperature and seepage.

Furthermore, it is designed to arrange strong seismic instruments at the dam crest, inside the dam, at dam abutment on both banks and D/S of the dam, to monitor dynamic response of the dam and seismic phase and vibration mode when earthquake.

6.3.9 Mitigation Measures against Flood Impacts

(1) Measures for forecasting hydrological information

According to relevant laws, regulations, standards and codes of China, in order to meet the needs of flood control during the construction and operation period, the automatic hydrological data acquisition and forecast system will be uniformly planned and set up for all cascades of Ngaw Chang Hka River, so as to conduct real-time collection and processing of meteorological data by applying such technologies as telemetering, communication and computer, conduct forecasting of hydrological data, and realize optimized dispatching of flood control, power generation and water supply, fully playing the benefits of the cascaded hydropower projects.

The river system of Ngaw Chang Hka Basin is relatively developed, and floods rise and fall quickly. By establishing corresponding acquisition and forecasting system during the construction period, we may adequately and timely grasp the development trends of rain data, hydrological data and floods of the basin U/S of the construction area, provide bases for making decisions about construction and management. It is an important means for ensuring safe construction, flood control and meeting the construction period. Moreover, it may accumulate forecasting experiences, collect the water and rain data in advance, so as to meet the needs for hydrological forecasting after the HPP put into operation.

(2) Reasonable arrangement of flood-release structures

Respectively, the designed and check flood recurrence period of Tongxinqiao HPP is 100-year and 1,000-year. In order to ensure flood control safety of the dam, in combination with the topographic and geologic conditions of the dam site, the layout means of retaining structures and reservoir operation requirements, three overflow surface outlets and two bottom flood releasing outlets are to be arranged at the riverbed dam section and both sides of it, which can flexibly meet the flood releasing needs of different reservoir water levels and seasons.

According to the calculation and test results, the flood-release capacity of the project can fully meet the needs of the abovementioned flood standards, with no accident of flowing over the dam crest. In addition, with a relatively larger release capacity to the overflowing orifices, the bottom releasing outlets can be served to empty the reservoir as soon as possible.

(3) Anti-seepage and drainage measures

In order to guarantee the dam stability in normal operation and under different flood levels, it is to arrange an anti-seepage curtain near the U/S foundation of the dam, with a drainage gallery and drainage hole curtain, so as to lower the osmotic pressure below the dam foundation and improve the antislide stability of the dam.

(4) Measures for mitigating scouringto the D/S river banks

In order to consume the energy of the releasing water and lower its flow velocity, it is planned to simultaneously take both the measures of energy dissipation and bank protection to mitigate the scouring of D/S river bank.

1) Energy dissipation measures

in order to make the releasing water to gently enter the D/S river channel, and reduce the flow velocity to that of natural flood within a relatively short distance, it is to arrange hydraulic energy dissipation structure both at the end of the overflowing surface orifices and the bottom releasing outlets.

According to the results of hydraulic model test, expansion pier bucket flow energy dissipation and ski jump energy dissipation will be adopted to effectively lower the discharge velocity.

2) Bank mitigation measures

In consideration of the hydraulic model test results and the geologic conditions of the D/S river channel, the flow velocity within a certain length in proximity to the outlets of the water-releasing structures will still exceed the natural status, it is necessary to take such engineering measures as grouted stone apron and reinforced concrete to protect the D/S river channel in case of destructive scouring.

6.3.10 Mitigation measures to the residual impacts

The mitigation measures include the workyard cleaning and recovering and solid waste treatment. The workyard need to be cleaning, mainly involving the temporary land, then the soil preparation and planting the endemic species. As to the solid waste, it shall be collected and transported to the spoil disposal area.

6.3.11 The summary of impacts and mitigation measures

The details of mitigation measures are shown in the table 6.3-1.

Table 6.3-1 The summary table of impacts and mitigation measures

EnvironmentalAspect/Issue	Impacts	Measures to avoid, prevent, or remedy impacts	Significance
The pre-construction period			
		Do the EIA studies	A+
		Do the feasible research on environmental protection before construction	A+
Construction period			
The aggregate processing system waste water	Waste water with high concentration in suspend solid, polluting the river water quality and affect the organism in water	Secondary sedimentation method and sediment disposal shall be handled through mechanical dewatering method, reuse the treated water	B-
concrete mixing system waster water High PH and SS	Waste water with high PH and SS, polluting river	Treat by neutralized sedimentation method, and reuse or discharge	B-
wastewater with oil	Oil and grease pollutes the river water from equipment repair workshop and automobile repair and maintenance workshop.	Using oil separating tank to treat the oil water	B-
Sewage	With high BOD, SS, COD, TN and TP in water	Using buried package domestic sewage equipment to treat domestic sewage	B-
Occupation of land	Kill the flora and disturb the habitat	Restoration of vegetations Publicity and Education landscape	B-
dust	highly concentrated dusts affected people and other organism in the area	Water spraying in dry seasons	B-
Vehicle exhaust	Polluting the air quality and the organsim	Managing the vehicles to keep good condition	B-
noise	noise pollution in the construction area because of high level noise produced by the running of mechanical equipment in construction excavation, blasting, transportation, aggregate processing, concrete mixing, etc. the quarry explores will cause the level of noise because of	labor protection for the workers shall be strengthened; Control the working time.	B-

	blast		
Solid waste	the domestic waste will become the hotbed of mosquitoes and rats, which will threaten population health, and the leachate may pollute soil and underground water.	collected for concentrated treatment on the domestic garbage and pile them at designated disposal areas to the spoiled materials	B-
	The construction waste will make the workyard in a mess and make block the river	Classifying the waste, the unused waste will be collected and transported to the spoil disposal area	B-
Social environemnt	infectious diseases and the input and output of pathogen. outbreak and wide spread of natural focus diseases, insect-borne infectious diseases, water-borne infectious diseases, endemic diseases,	Cleaning the drinking water disinfecting the working and living places, making the close monitoring and so on	A+
	Occupy the cultivated land and so on, affecting the normal life	economic compensation	A+
	222 people need to relocated	Rsettlement plan	A+
Operation period			
sewage	Affect the water quality of river	Keep on using the buried package domestic sewage equipment in construction phases	B-
Territorial ecosystem	Kill or affect the flora and fauna	Strengthen Management, prohibit them to hunt and kill wild animals	B-
Aquatic ecosystem	the sphere of activity of the fishes will be limited/	Protecting the tributaries	B-
Solid waste	The same as the construction period	Collecting and transporting to the disposal area	B-
Reservoir inundated	Affect the water quality	Reservior cleaning	B+
		Reservoir management and monitoring	B+
Environmental accident	Oil will pollute the river	a public oil pond; waste oil treated through an oil-water separator shall be recovered and wastewater shall be used for watering of	B+

		road, plant et	
Social environment	Affect the local econimic	Implement the CSR	A+
earthquake	Threat the dam safety	foundation treatment measures, aseismic measures, reservoir emptying measures and safety monitoring measures for dam, powerhouse and other key parts of seismic fortification.	B-
flood		energy dissipation and bank mitigation measures	B-
Cumulative impacts	Bad to organism	Implement biodiversity conservation plan	B-
	Polluting the water	Monitoring and management	
Local People's production and living	Disturb the environment	Implement monitoring plan	A+
Environmental risk	emergent environmental incident	Write and implement contingency plans	A+
Decommissioning Period			
Still using	Affect the environment	to carry out EIA newly	A+
removing	Solid waste	Pile them at designated disposal areas	B+
	Block the river		B+
	cause impacts on the quality of local ecosystem and landscap		B+

A-: Significant Negative Impact A+: Significant Positive Impact

B-: Some Negative Impact B+: Some Positive Impact

C: Impacts are not clear, need more investigation

D: No Impacts or Impacts are negligible, no further study required

6.4 Impacts in Decommissioning phases and Mitigation Measures

After maturity of service life of the project, there may be two working conditions, one is to continue using the HPP, and the other is to dismantle the dam. In this chapter, two different working conditions are analyzed as followed:.

6.4.1 Continuing Operation and Production After Maturity of Service Life

After maturity of the service life of the project, if it passed safety monitoring and determined to continue production, it will be necessary to carry out EIA, and assess the environmental impacts of the project operation.

6.4.2 Decommissioning the HPP after Decommissioning phases

(1) Environmental impacts of decommissioning the HPP

1) Ecosystemal impacts

Decommissioning works will be performed in the complex works of the HPP, without additional surface disturbance. Entry and exit of vehicles will also follow the original access road of the HPP, which will not cause direct impact on the local vegetations, animals or plants, only that there will be transient impacts of decommissioning construction on the acoustic environment and atmospheric environment, thereby indirectly affect the survival and activities of animals and plants,which will also be eliminated with the completion of construction.

2) Water environmental impacts

Water quality of decommissioning works is still good, debris, dust, wastewater of wet-process operation and rainwash in the course of construction will also enable some pollutants to enter the water body, resulting in density of SS in the water body to rise. However, since the project has short construction period and small quantity, it will have limited impacts on the water body.

3) Acoustic environmental impacts

Noises of decommissioning works will mainly come from drilling holes, blasting, bulldozers and transportation. Analogizing with the measured values of other similar projects, noise level of construction area of the decommissioning works will be about 92dB(A); this project will need to be conducted dense-holes controlled blasting operations, and the blasting noise source intensity will be about 120 dB(A) ~140 dB(A); the vehicle noises in the transportation of spoiled materials will be about 80 dB(A).

The HPP to be dismantled is located at a remote mountainous area, construction noises will cause certain disturbance to the local birds and ordinary terrestrial animals. With the completion of the decommissioning works, such disturbing impacts will disappear immediately. Therefore, the acoustic environmental impacts generated by the decommissioning works will be very limited.

4) Air environmental impacts

In the course of decommissioning operation, drilling, cutting, loading and unloading spoiled materials and blasting will generate dust pollution. However, since the decommissioning quantity is small and the time is short, after duly conducting conventional protection to the

construction personnel, the environmental impacts of decommissioning works on the air quality will be very trivial.

5) Impacts of solid wastes

a. Impacts of spoiled materials

The total quantity of structures to be dismantled will be 60×10^4 m^3, mostly being concrete debris, earth-rock excavation and waste metal residues. If they are randomly piled, they will cause impacts on the quality of local ecosystem and landscape. It is necessary to pile them at designated disposal areas according to the requirements in the water and soil conservation codes.

b. Impacts of domestic garbage

The decommissioning works will involve short construction period and limited number of people, and the domestic wastes to be generated will be limited. However, random disposal will still cause impacts on the local ecosystem, and it is necessary to have them collected for concentrated treatment.

6) Social environmental impacts

Because of the small capacity of the power station, the impacts of decommissioning works on energy production will be limited.

(2) Environmental mitigation measures of decommissioning works

In the construction of decommissioning works, it is mainly to generate spoiled materials and it is to conduct protection against spoiled materials herein. The total quantity of structures to be dismantled will be $60\times10^4m^3$, mostly being concrete debris, earth-rock excavation and waste metal residues. As to concrete and other waste residues no longer useable, it is to find a proper low-lying land around the HPP for landfill. Steel and other waste metal residues will be collected for reuse.

7 Risk Assessment

7.1 Methods and Means of Assessment

Through assessment of environmental risks, such as risk identification, risk analysis and risk consequence calculation, it is to provide data and bases for engineering design, environmental management and environmental risk prevention, so as to realize the purpose of lowering danger and reducing harms. It is to further design preventive measures against environmental risks and emergency plan in an all-round manner, and solve the problem of environmental risks.

According to the scale and construction characteristics of this project and the surrounding environmental characteristics, during the project construction period, the potential accident risks and environmental risks mainly include: the risk of liquid ammonia leakage of concrete batching plant, ecosystemal risks, fire risks, water pollution risks, and etc.

7.2 Environmental Risk Impact Analysis and Contingency Plan

7.2.1 Construction Period

(1) Analysis about Main Environmental Risks

1) Impacts of liquid ammonia of concrete batching plant during the construction period

Liquid ammonia is combustible and irritating, with serious environmental harms, which will cause pollution to the waters, soil and atmosphere. It may form explosive mixture when mixed with air, and cause combustion and explosion when encountering open fire or intense heat. In case of intense heat and increase of pressure inside the container, there will be the danger of cracking or explosion. Inhalation of gas ammonia may cause serious intoxication, asphyxia or death of human body, while liquid ammonia may cause eye burn or blindness, and burn of skin. Low-density ammonia is irritating to mucous membranes, while high-density ammonia may cause lytic necrosis of tissues, chemical inflammation and burn of skin and mucous membranes of upper respiratory tracts, ephemeral pneumonia, pulmonary edema and bleeding, etc. It is environmentally harmful, which may cause atmospheric pollution, and cause frostbite of animals and plants.

2) Analysis on the ecological impacts

The impacts of reservoir submerging and construction land occupation on the terrestrial animals are mainly that the habitats of animals in the area will shrink, so that they have to

migrate to other areas. During the construction period of the HPP and initial storage period of the HPP, the number and population of terrestrial vertebrates will tend to decrease, and with the completion of the project construction, the population and number of terrestrial vertebrates in the region will gradually restore. The project construction will have certain impacts on the IUCN protected species distributed in the project area. In general, project construction will have limited impacts on terrestrial animals, and will not cause the terrestrial animals to disappear from the area.

Rare and endangered plants under protection in the area directly affected by the project should be transplanted. The ones that cannot be transplanted should be taken such protective measures as seedling breeding, etc. Simultaneously, it is to reinforce control of such acts as illegal logging and hunting. After taking the above measures,the project construction will have relatively low ecosystemal risks.

3) Risk analysis of oil depot, explosive magazine and fire

Accidents like leakage and explosion of oil depot, explosion of explosive magazine and using fire in the field will have great environmental risks.

Considering that the oil depot and explosive magazine will be constructed, used and operated by professional design, construction and management people according to the idea of safety first, and the oil depot and explosive magazine will have emergency plans, whose environmental risks will be limited. Since the forest cover rate around the project area is relatively high, the environmental risks caused by construction personnel using fire in the field will be great, it is necessary to exercise strict management, so as to avoid such accidents.

(2) Preliminary emergency plan for environmental risks

① According to the environmental characteristics of the project area and the neighboring areas, it is to try to arrange the dangerous sources like oil depots and explosive magazines and keep safe distance away from construction personnel's living quarters and the Employers' camp, etc.; it is to formulate strict safety management system for the oil depot; it is to arrange fire prevention dikes and firefighting water tanks; it is to equip with certain number of emergency equipment and apparatus for oil spill control and equipment for electrostatic prevention; it is to formulate strict systems for fire prevention and fire use; it is to formulate and strictly implement blasting procedures, etc.; There is not settlement around the concrete batching plant. In case of ammonia leakage, the person responsible for the shift should firstly evacuate the construction personnel from the site, request the professional emergency people

to be mobilized to the site, and duly conduct treatment to eliminate the impacts of liquid ammonia.

②It is to formulate risk accident emergency plans. To be specific, it is to set emergency procedures by the four stages of information reporting, early treatment, emergency response and emergency conclusion.

The project construction surely will be accompanied with potential harms. If the level of preventive measures is high, the probability of accident will surely be lower, but there still is the possibility of accidents. Once there is an accident, it will be necessary to take emergency prevention measures to control and minimize the harms of the accident. It is also necessary to formulate contingency plan and implement relevant measures, which specifically include defining emergency planning areas, such as defining oil depot area, explosive material area and environmental protection objective area, etc.; it is to determine the emergency organization and personnel, including determining emergency leading organization, site directors, emergency rescuers, graded responses to preplan, emergency rescue guarantee, reporting to police, means of communication, emergency monitoring, rescue and control measures, emergency mitigation measures, organization plan for evacuating and withdrawing personnel, accident emergency rescue closure procedure and restoration measures, emergency training plan, public education and information publicity, etc.

Through designing and effective implementation of the emergency plan, we may minimize the environmental risks, and minimize the adverse impacts caused by environmental risks, such as various engineering safety, construction schedule and investment risks, etc.

7.2.2 Operation Period

The operation period mainly involves the dam failure risk caused by earthquake and flood, river water pollution risks caused by water quality pollution of the U/S and reservoir area, and impacts on ecosystem, etc.

7.2.2.1 Analysis about Dam Failure Risks caused by Earthquake and Flood and Contingency Plan

Focusing on the dam safety issue that may be caused by earthquake and flood, a great deal of geological exploration, data collection, site investigation, calculation and analysis have been conducted strictly during the course of investigation and design of Tongxinqiao HPP, referring to experiences of other hydropower projects.

According to the seismic safety evaluation and flood calculation results of the project site, the corresponding seismic protection and flood design standards have been ditermined according to the project scale and the grade of dam. Based on that, calculation and analysis indicate that the dam stability of Tongxinqiao HPP conforms to the stipulations of the relevant design specification, and dam failure will have no opportunity to happen under the conditions of designed earthquake and flood level.

However, considering the importance of the project and the serious consequence once accident, it is absolutely necessary to draw up the contingency plan for dam failure, mainly has the following leitmotiv to be involved:

Once the accident of dam failure is to be happen, above all, it is to send out alarms by any available means to the people and hydropower projects in the D/S area in case of induced flood, request them to emergently evacuate from the areas that may be flushed by the streams in the river valley, so as to guarantee safety of the people's lives and properties in the D/S area.

7.2.2.2 Analysis about Water Environmental Risks

Under normal working conditions, the impacts of the project on water environment will be limited. Once there is a malignant pollution accident in this project or the U/S inflows, it will be necessary to firstly initiate the contingency plan for sudden environmental pollution incident, control the discharge of pollutants from the origin, collect or hinder pollutants, and try to control them from entering the D/S area.

7.2.2.3 Analysis about Ecosystemal Risks

The barrier effect of the dam is to hinder the genetic exchanges of fishes. It is particularly noteworthy that once all the hydropower projects in the basin are completed, it will have adverse impacts on the connectivity of fish habitats and exchanges of biological resources. However, considering that the basin investigation results found that there is not long-distance migratory fish in the river, nor is there any rare or protected fish, the aquatic ecological risks of construction and operation of the HPP will be limited. However, as to terrestrial ecology, since the regional vegetation canopy is high, the diversity of animals and plants is abundant, there are many kinds of rare and protected animals and plants, with abundant resources, once the project is completed and put into operation, the human reachability of the region will be improved, which may result in greater risk of the ecosystem brought by human activities.

Therefore, with the completion and operation of the HPP, the Employer should consult the local government to establish a uniform environmental management organization of the basin, reinforce management, and prohibit any kind of illegal forest logging or hunting, so as to minimize the risk of project construction on the ecosystem.

8 Cumulative Impact Assessment

Considering that 4 cascaded hydropower projects are planned to be developed from U/S to the D/S of Ngaw Chang Hka Basin, part of the environmental impacts of all the cascades will mutually overlap for the relation of time and space. In the long term it will have cumulative environmental impacts. Therefore, it is necessary to carry out cumulative impact assessment.

8.1 Assessment Method

The cumulative impact assessment of this project is oriented to different environmental factors, with expert consultation, matrix method , mathematical model and overlaying method, etc. For example, it is necessary to conduct expert consultation method for rare and protected animals, plants and fishes, etc.

8.2 Assessment Objectives

The evaluation objects mainly include environmental factors that may be subject to affect the U/S cascades project construction and that may cause impacts on the D/S Lawndin HPP project construction, mainly including terrestrial ecology, aquatic ecology, hydrological regime and social environment, etc.

8.3 Scope of Assessment

Tongxinqiao HPP is the third cascade planned on Ngaw Chang Hka River. The scope of its directly environmental impacts is from the reservoir tail of Tongxinqiao HPP to reservoir tail of Lawndin HPP. The range of its cumulative environmental impacts is the whoel river, which is from Lawndin HPP to Gawlan HPP. Namely, the specific range is extended to the all river reach, which is from powerhouse of Lawndin HPP to the reservoir tail of Gawlan HPP, the range of water catchment area on both banks of the river reach, as well as the settlements that may be indirectly affected by the sphere of influence.

8.4 Brief Introduction to the Projects with cumulative Impacts

8.4.1 Brief Introduction to Gawlan HPP

Gawlan HPP is located in the middle and lower reaches of Ngaw Chang Hka River in the territory of Kachin State, Myanmar, upstream of Hkankawn HPP in the 4-cascade development scheme of Ngaw Chang Hka River. The dam site is about 500m U/S of the confluence of the tributary Lawng Mow Hka River and Ngaw Chang Hka River. The FSL of

the HPP will be El. 1510m, the corresponding storage capacity will be $1.36\times10^6m^3$, with daily regulating properties, and the installed capacity will be 120MW.

The complex works mainly comprise concrete gravity dam, L/B headrace system and ground powerhouse, dam overflow surface outlets, L/B desilting bottom outlets, R/B flood-release bottom outlets, plunge pool, L/B and R/B non-overflow dam sections and R/B diversion tunnel.

8.4.2 Brief Introduction to Hkankwan HPP

Hkankwan HPP is located in the middle and lower reaches of Ngaw Chang Hka River in the territory of Kachin State, Myanmar, upstream of Tongxinqiao HPP in the 5-cascade development scheme of Ngaw Chang Hka River. The dam site is about 500m U/S of the confluence of the tributary Lawng Mow Hka River and Ngaw Chang Hka River. The FSL of the HPP will be El. 1,220m, the corresponding storage capacity will be $4.87\times10^6m^3$, with daily regulating properties, and the installed capacity will be 140MW.

The complex works mainly comprise concrete gravity dam, L/B headrace system and ground powerhouse, dam overflow surface outlets, L/B desilting bottom outlets, R/B flood-release bottom outlets, plunge pool, L/B and R/B non-overflow dam sections and R/B diversion tunnel.

8.4.3 Brief Introduction to Lawndin HPP

Lawndin HPP is located in the lower reaches of Ngaw Chang Hka River in the territory of Kachin State, Myanmar, which is the cascade next to Tongxinqiao HPP, and also the last cascade in the4-cascade development scheme of Ngaw Chang Hka River.

The HPP is to be adopted the means of trans-basin headrace development. Hydraulic power is from the tributary Ngaw Chang Hka River to mainstream Nmai Hka River, the U/S water level will be connected with the tailwater of Tongxinqiao HPP, while the D/S is to be connected with the FSL of Chibwe HPP on Nmai Hka River. The dam site is located about 1.1km U/S of the confluence with Lan Ga Hka River, about 3.5km away from the D/S Lawndin Bridge across the river, and the L/B of the dam site in the U/S is Myaw Chawng Village.

The FSL of Lawndin HPP will be El.783m, the installed capacity will be 600MW, the storage capacity of the HPP corresponding to FSL will be $66.9\times10^6m^3$, and the regulating storage

capacity will be $39.7\times10^6m^3$, with seasonal regulating capacity.

The complex works mainly comprise CFRD, L/B spillway, L/B headrace system and ground powerhouse, R/B desilting tunnel and R/B diversion tunnel.

8.5 Cumulative Impact Analysis and Mitigation Measures

The cumulative impacts are the overlaying environmental impacts of past, present and future actions. From the perspective of scale, its effects are mainly manifested in time and space. The cumulative impacts come from the activities which occurred in a period of time, with very limited independent impacts, but very great collective impacts.

General accumulative impact effects may be classified as 8 categories, i.e., time crowding effect, space crowding effect, complex effect, time lag effect, and space lag (boundary expansion) effect, closed value effect, indirect effect and crushing effect.

Minimization of cumulative impacts mainly include the following few aspects:

(1) Minimum accumulation degree: Accumulation degree reflects the accumulation degree of environmental effects or cumulation degree on time and space scale. The lower the adverse accumulation degree is, the less harm hydropower development will cause to the eco-system;

(2) The smaller accumulation area: The size of the accumulation area reflects the spatial distribution characteristics of environmental effects or impacts of hydropower development, the smaller the adverse accumulation area is, the small range of adverse impacts of hydropower development effect on the ecosystem;

(3) Minimum accumulative time domain: Accumulative time domain reflects the time distribution range of environmental effects or impacts of hydropower development, the lower the unfavorable accumulative time domain is, the lower adverse impacts of the hydropower development may impose on the eco-system.

The characteristic of environmental impacts of cascade development on Ngaw Chang Hka Basin is that it is accumulative, which may be described from the following aspects:

8.5.1 Water Environment

(1) Hydrological regime

The Ministry of Electric Power of Myanmar claims that this project shall not connected with the Hkankwan HPP in the U/S and Lawndin HPP in the D/S. There are still retain natural river

reach between the tail water level of Hkankwan HPP and the terminal of backwater of Tongxinqiao HPP. Likewise, there are still retain natural river reach between the tail water level of Tongxinqiao HPP and the terminal of backwater of Lawndin HPP.

Gawlan HPP, Hkankwan HPP and Tongxinqiao HPP are run-off-river station, and Lawndin HPP is the seasonal regulation. It will not have any impacts even the Gawlan HPP, Hkankwan HPP, Tongxinqiao HPP, and the Lawndin HPP combine running. There will be the water reducing river, 9.95km, 6.5 km, 14.7km, and 28.9 km respectively, and the reservoir length, 0.85km, 4.0 km, 2.65 km and 10 km respectively.

Table 8.5-1 The river stream status table after four dam built

Dam site	The reservoir length	Reducing reaches	Remark
Gawlan	0.85km	9.95km	
Hkankawn	4.0km	6.5km	
Tongxinqiao	2.65km	14.7km	
Lawndin	10.0km	28.9km	

Considering that there are many tributaries downstream of the dam, whose flow are more than 10% of the annual average flow at the damsite. It will guarantee the river not dry up and meet the river ecological water use.

The upstream 3 HPPs are run-off-river station. So there will be no cumulative impacts to the whole river. But as to the Lawdin HPP, it will affect water quanlity on the Nmai Hka river and downstream of the Lawdin dam. Its diversion flow nearly accounts for 10% of the Nmai Hka. Its impact on Nmai Hka will be small.

Hydrographic conditions (flux, velocity, and water level) will not be changed after joint operation of four cascades reservoirs. It is the same as single HPP operating.

In a word, considering the rain is abundant in this area. The probability of extreme situation is not often, so the adverse impacts can be forecasted and be solved by some mitigation measures such as operation regulation, controlling the reservior filling time and power generation.

(2) Water temperature

The water temperature structures of Hkankwan HPP, Tongxinqiao HPP, and Lawndin HPP are mixed reservoirs. There will be little variation in the water temperature of reservoir and D/S river. Accumulative impact on water temperature will not happen after joint operation of

cascades reservoirs.

(3)Water quality

Hkankwan HPP and Tongxinqiao HPP are the daily regulation, and Lawndin HPP is the seasonal regulation. The regulation performance is poor. The water of reservoir exchange is frequent. Accumulative impact on water quality is small. The water quality mainly depends on water quality from U/S river.

8.5.2 Terrestrial Ecology

(1) Accumulative impacts on the forest.

Cumulative impacts on the forest is relation with the features of geography landform and physiognomy. Evaluation river belongs to canyon river. The construction area and reservoir inundation area are less. So the forest remains basically. There are few people in this area. Living and production have little influence on local forest after reasonably managing and forbidden deforestation. Besides, water surface area of this area will increase, reservoir microclimate will change after this three HPP completed. The concentrations of water from the air will be raised, which is beneficial to forest growth.

(2) Cumulative impacts on the plants

1) Cumulative impacts on the plants

After cascade hydropower stations is built, some small new village will form near the plants. Land occupation will destroy some plants. Besides, Surrounding lands also will be used to development of farming and services, which will affect plants adversely.

2) Cumulative impacts on the endangered plants

The mainly distributed endangered plants in evaluation area are described in in Table 8.5-2 There are only one endangered protection plant in evaluation area of Tongxinqiao HPP, i.e., *Schima wallichii*, which is a vulnerable species. This species is not as timber species and widely distribute in surrounding areas. Human activity have less impacts on it. In general, there will be less impact on the endangered plants.

Table 8.5-2 The mainly distributed endangered plants in evaluation area of three HPP（IUCN red list）

Hkamkawn HPP	Tongxinqiao HPP	Lawndin HPP
Schima wallichii (VU)	*Schima wallichii (VU)*	*Syzygium zeylanicum(EN)*
Dalbergia oliveri (EN)	*Anisoptera scaphula(CR)*	*Hopea sangal(CR)*
	Magnolia rostrata Smith.(VU)	

(2) Cumulative impacts on terrestrial animals

1) Cumulative impacts on terrestrial animals

Cumulative impacts of HPP development on terrestrial animals reflect in its developed. Once developed, many people will enter the area, human activity will destroy habitat of wild animals, Some have strong activity or agile performance will flee the area, so animal distributionstructure will change in a certain degree.

2) Cumulative impacts on endangered terrestrial animals

In total, there are some endangered terrestrial animals such as *Manis javanica*(EN)、*Manis pentadactyla* (EN)、*Hoolock hoolock*(EN)、*Cuon alpinus*(EN)、*Ursus thibetanus*(VU)、*Helarctos malayanus*(VU)、*Catopuma temminckii* (VU)、*Rusa unicolor* (VU)、*Hystrix brachyuran* (VU)、*Aceros nipalensis* (VU), and so on. These animals have stronger ability to move and adapt. So they will not be harmed directly. Fauna compose will not be changed also in this area. In general, there will less impact on the endangered terrestrial animals.

Table 8.5-3 The mainly distributed endangered terrestrial animals in evaluation area of three HPP（IUCN red list）

Hkamkawn HPP	Tongxinqiao HPP	Lawndin HPP
Manis javanica(EN)	*Manis javanica(EN)*	*Manis javanica(EN)*
Manis pentadactyla(EN)	*Manis pentadactyla(EN)*	*Manis pentadactyla(EN)*
Hoolock hoolock(EN)	*Trachypithecus shortridgei(EN)*	*Trachypithecus shortridgei(EN)*
Cuon alpinus(EN)	*Hoolock hoolock(EN)*	*Hoolock hoolock(EN)*
Ursus thibetanus(VU)	*Cuon alpinus(EN)*	*Cuon alpinus(EN)*
Helarctos malayanus(VU)	*Ursus thibetanus(VU)*	*Ursus thibetanus(VU)*
Catopuma temminckii (VU)	*Helarctos malayanus(VU)*	*Helarctos malayanus(VU)*
Rusa unicolor (VU)	*Catopuma temminckii (VU)*	*Catopuma temminckii (VU)*
Hystrix brachyuran (VU)	*Rusa unicolor (VU)*	*Rusa unicolor (VU)*
Aceros nipalensis (VU)	*Hystrix brachyuran (VU)*	*Hystrix brachyuran (VU)*

	Aceros nipalensis(VU)	*Aceros nipalensis(VU)*
		Sitta formosa(VU)

8.5.3 Aquatic Ecology

After Tongxinqiao HPP is built, the originally integral and continuously connected river aquatic ecosystem will be divided as 4 sections of different habitat units, which are river reaches with unchanged total discharge but great fluctuation of daily discharge, river reach with low water level, river reach of reservoir, and normal river ecosystem, causing river habitat to be fragmented. Once Tongxinqiao HPP operates, the flow between the powerhouse and the dam will reduce, it will cause obviously adverse impacts on the aquatic organisms in the river reach. However, upstream of the dam site, due to changes of flow velocity in the river reach of the reservoir, the reservoir will be a island habitat with fragmental ecosystem, and when the habitat changes, the damaged habitat may be the living area of certain species.

Fragmental habitat may cause the diffusion of species and establishment of communities to be restricted, it will cause direct hindrance to the normal spreading and resettling activities of species. Once the species of a single habitat die in natural succession and population metabolism, the new species cannot enter the segmented habitats due to hindrance of dam, the number of species will inevitably tend to decrease. Another harm of habitat fragmentation is to decrease the searching ability of fishes in the reservoir area. Many fishes, no matter single individuals or social groups, will need to be able to freely run across the habitats in the distribution area, and forage in sporadic bait resources. Since the habitats are divided, the species are restricted in a narrow area and cannot look for decentralized food resources, and there will be hungers and cause serious degradation of habitats. The impacts of fragmentation also has another manifestation such ascausing restriction on the fishes to look for mates and spawning and fertilization, or reducing the chance that affects reproduction.

Once Tongxinqiao reservoir is built, part of the original flowing water environment will be replaced by reservoir environment, the river will be changed to several habitat units. Although this river reach does not involve the issue of migratory fishes, many fishes need short-distance fish foraging, spawning migration, and shrinkage of survival space will directly affect the completion of living history of these fishes. The impacts of construction of Tongxinqiao HPP on the hindering effects of fishes and completion of living history of fishes will be limited, especially the non-migratory fishes.

However, the entire Ngaw Chang Hka River development will impact on the feeding, growth and reproduction of fishes will be far reaching. Such impacts will be gradually increased with the increase of the number of cascade development, and the hindrance will be gradually enlarged.

The impacts on aquatic organism by Cascade development of will run across all the periods with changes of basin properties. Therefore, as to the impacts of development of Tongxinqiao HPP, it is not only necessary to consider the past and present impacts, but also the future impacts. According to the development scheme, Tongxinqiao HPP will be the first cascade to be developed. The cascades to be subsequently developed should be comprehensively considered based on the impacts of Tongxinqiao HPP on the impacts of waters, which will be good for learning the overlapping impacts of Tongxinqiao HPP on its development.

8.5.4 Social Environment

(1) Economic growth effects

Hkankwan HPP, Tongxinqiao HPP and Lawndin HPP have a production capacity of 1080 megawatts. The region economy will develop coordinately, environment of investment will improve. Local fiscal revenues will increase and sustainable capacity of this area will enhance after joint operation of cascades reservoirs.

(2) Rolling development effects

Ngaw Chang Hka Basin is to be constructed cascades, since it is to be developed rolling and implemented by steps. In comparison with separately constructing Tongxinqiao HPP, it will have obvious effects of cost saving. As to Hkankwan HPP in its U/S and Lawndin HPP in its D/S, their cumulative social impacts mainly include:

Firstly, it may save cost of raw materials. Since cascaded HPPs can be constructed on the basis of fully utilizing the original infrastructures and basic equipment of Tongxinqiao HPP, repeated construction can be reduced by considerable degree.

A lot of coal, cement, steel, aggregate and other raw materials will be required for the cascaded HPPs construction. We may avoid wastes of repeated construction to a considerable degree, so as to save cost of raw materials by uniformly planning the construction of roads and houses, resettlement and construction of settlements necessary for all the cascades,

Secondly, the start-up cost for construction of other cascades may be reduced. The initial costs

of individual cascades may be reduced and the start-up costs may be lowered by uniform planning, design and tendering of the cascaded HPPs.

Thirdly, it may safeguard financial sources and save financing costs. Implementing rolling development may make up the tremendous gap of costs. With the rolling development, the benefits of Tongxinqiao HPP can be the costs for construction of subsequent cascades, which may safeguard the construction costs of the other cascades. It will not only solve the problem of financial inputs, but also may save financing costs.

(3) Amplifying effects

As to generation benefits of the cascaded HPPs, except adding up the energy production benefits of individual cascades, the integral generation benefits may be amplified through taking such measures as reservoir regulation among the cascades, so that the overall generation benefit will be higher than the total generation benefit of individual cascades, i.e., construction of Tongxingqiao HPP in advancewill be good for construction of other cascades in the U/S and the D/S.

(4) Studying effects

The development process of cascaded HPPs will be a repeated production process, and development of subsequent cascades will have the improved efficiency and quality due to the studying effects of Tongxinqiao HPP, thus save costs. In the course of constructing the cascaded HPPs, the technicians and managers may apply and innovate technologies in construction practices, conduct exchanges, transmissions and studies of knowledge, skills and innovative technologies between the U/S and the D/S cascades, which may improve the construction quality and management level of the cascades, and improve the working efficiency.

(5) The adverse impacts

The building of HPPs will take more people into the field, which will affect the society. The impacts include the security, the agriculture, health and so on. They will impact the local people, which someone's farm is occupied and so that the imcome will be diminish.But it can be mitigate by the other side, such that the HPP's will build the road, which is good to their their trip and so on. Other impacts have been decribed in other paragraph, such as the feeling of security of local people in the Public Participation section.

9 Environmental Management Plan

9.1 Goals and Tasks

(1) Mastering the dynamic change of environment of HPP of complex works to provide scientific basis for control of environmental pollution during the construction and operation periods, environmental management of ecological damage, and environmental protection works for development of cascade hydropower project of basin.

(2) Timely mastering implementation results of the mitigation measures; Prevention of the sudden accident harm on the environment; To provide basis for acceptance of environmental protection upon completion of the Project.

(3) To inspect the environmental impacts and predict the evaluation results.

(4) To provide scientific basis for research of ecosystem of the Ngaw Chang Hka River Basin.

9.2 Environmental Management Plan

Environmental management is part of the project management and a important step for effective implementation of project environmental protection. The purpose of the construction project environmental management is established to ensure smooth implementation of all environmental mitigation measures, mitigate negative impacts on the environment caused by project construction, preserve ecological stability of landscape, and promote harmonious sound development of social economy and ecosystem in the construction area of the HPP. The detailed management plan is shown in Table 9.2-1.

9.2.1 Environmental Management System

Environmental management of the Tongxinqiao HPP includes external management and internal management.

The external management is that the Republic of the Union of Myanmar and local government carry out irregular supervision, inspection, acceptance of environmental protection upon completion, etc. to the construction stages of each works in accordance with related national laws, regulations, and policies of Myanmar, as well as environmental standards and requirements need to be reached by the Project.

The Internal management means that the Employer implements laws, regulations, and policies

related to environmental protection of the Republic of Union of Myanmar and local government, practice environmental mitigation measures, and carry out management for project process and activities according to the environmental protection requirements. The internal management includes the management of construction period and the management of operation period. During the construction period, the Owner should be responsible for the internal management, carrying out optimization, the organization and implementation of environmental mitigation measures ， guaranteeing the achievement of the Myanmar national and local requirements of the Republic of Union of Myanmar and local government. The internal environmental management system in the construction period consists of the owner, Contractors, design unit, and supervision unit. They are responsible for environmental protection of the project construction via corresponding agencies established by them. During the operation period, the unit for management of project operation should be responsible for optimization, organization, and implementation of the mitigation measures.

9.2.2 Environmental Management during Construction Period

(1) Environmental Management Organizations and Their Responsibilities

The environmental management system in construction period of Tongxinqiao HPP consists of environmental management office of the Owner units, environmental supervision organization, and environmental management office of the Contractor.

The environmental management office of the Owner has overall responsibility for management of environmental protection , it must supervise, coordinate and urge theowner that accords to contract articles, approved environmental impact report and its reviewed comments in the construction area. They organize and implement the design, construction, and operation management of various environmental mitigation measures .

The environmental supervision organization is undertaken by unit with supervision qualification ， it supervises, reviews, and evaluates the implementation of the mitigation measures of the construction units according to contract articles and environmental protection laws, regulations,and policies of the Republic of Union of Myanmar, and based on environmental monitoring data and patrol inspection; Duly finding and correcting the construction behaviors that violate the contract articles and environmental protection requirements of the Republic of Union of Myanmar.

Environmental management office of the Contractor is the main responsible organization and reception organization for environmental protection in the project construction period. It implements the environmental protection undertaken by specific construction units in accordance with the environmental protection and water and soil conservation tasks regulated in the contract articles and Bidding Documents.

(2) Environmental Management of the Owner

The Construction Unit should actively organize and carry out bidding design for each mitigation measures according to bidding design results in bidding design stage, and are responsible for environmental protection management from construction to completion acceptance, its main tasks are to:

1) Review design contents of the project environmental protection and bidding contents;

2) Be responsible the bidding design results of environmental mitigation measures incorporating into Bidding Documents and contract with the Contractors;

3) Formulate annual work plan for environmental protection;

4) Review and arrange expenditure of environmental protection;

5) Supervise implementation of the environmental mitigation measures of the contractors;

6) Arrange environmental monitoring;

7) Supervise the implementation of mitigation measures related to resettlement;

8) Prepare interim reports for annual environmental protection;

9) Other matters.

(3) Environmental Supervision

1) Supervision Contents

Following the guidelines,policies, laws, and regulations of the Republic of the Union of Myanmar and local government, the supervisor organizationsupervises the contractors to implement related environmental protection articles in the contract agreement. The main responsibilities are to:

① Formulate environmental supervision plan; Prepare environmental supervision items

and contents.

② Supervise the contractors to prevent and reduce environmental pollution caused by construction operation, damages to the wild animals and plants and avoid forest fire.

③ Supervise and inspect implementation and effect of mitigation measures of the construction units, timely deal and resolve environmental pollution events occasionally occurred.

④ Inspect treatment and recovery of slag yard and construction site under responsibility of the contractors; the inspection contents include slope stability, site recovery, greening measures and effects, etc.

⑤ Be responsible for implementing environmental monitoring, reviewing relevant environmental reports, and putting forward corresponding requirements for construction and management of the HPP according to monitoring results of water quality, air, noise, etc. to reduce negative impacts on environment caused by project construction as much as possible.

⑥ Make supervision records and reports in daily work; Organize quality evaluation and participate in completion acceptance.

2) Supervision system

① Record system

The environmental supervising engineer formulates work record (supervision diary) according to the work condition. Key contents of the work record include patrol and inspection of the site environmental protection, pointing out existing environmental problem, responsibility unit for the problem, analysis of the main reasons for the problems, and handling processing advice and result.

② Report system

The environmental supervising engineer should organize to prepare environmental monthly report, quarterly report, semi-annual report, and annual report of the supervising, as well as monthly environmental report of the contractor; all the above reports should be submitted to the environmental management office of theOwner.

③ Communication system

The environmental supervising engineer should issue letter of notice to the contractor to rectify or deal with environmental problem found in the site inspection. The supervising engineer must inform the contractor in written form about stipulations or requirements for the contractor in some respects. Oral notice is feasible under emergency condition, but written form must be provided afterwards.

④ Systems for regular environmental meeting and issue of meeting minutes

Environmental protection meeting should be convened once a month. During the meeting, contractors should retrospect and summarize work of that month, and the environmental supervising engineer should implement overall comments on environmental protection of each section in the month. Meeting minutes should be formulated after the meeting and sent to parties attending the meeting. The environmental supervising engineer should urge related companies to implement as the Minutes.

After a major environmental pollution and impacts accident, the environmental supervising engineer should organize an investigation on the environmental accident and study the treatment scheme together with the Owner and local environmental protection administration, and then distribute to the Contractors for implementation.

3) Organization and work mode

Environmental supervision is a major part in environment management; meanwhile, it is relatively independent. So, the environmental supervision organization belongs to the environmental management organization, and the Environmental Supervision Department should be established.

(4) Environmental Management of Contractors

An Environment Management Office should be established in the Contractorsof the Project. It is responsible for implementation of environmental protection policies and measures stipulated in the Bidding Documents, and accepts supervision and management of the "Environmental Management Office" of the Owner. The main work is to:

1) Formulate annual work plan for environmental protection;

2) Implement measures of the project environmental protection and deal with problems occurred;

3) Check the use of annual environmental protection cost;

4) Inspect construction progress, quality and operation situation of the environmental protection facilities;

5) Deal with daily matters.

The Environmental Protection Office of project Owner should be established upon mobilization of the Contractors, and be withdrawn after the project completion and qualified acceptance.

9.2.3 Environmental Management during Operation Period

Responsibilities of environmental management is to :

1) Formulate annual work plan for environmental protection;

2) implement the environmental protection cost;

3) Coordinate with other Departments and arrange environmental monitoring;

4) Prepare annual report for environmental protection;

5) Other matters.

Environmental management plan are shown in Table 9.2-1.

Table 9.2-1 Environmental management plan

EnvironmentalAspect/Issue	Impacts	Measures to avoid, prevent, or remedy impacts	Responsible Unit
The pre-construction period			
		Do the EIA studies	Consultant and the Owner
		Do the feasible research on environmental protection before construction	
Construction period			
The aggregate processing system waste water	Waste water with high concentration in suspend solid, polluting the river water quality and affect the organism in water	Secondary sedimentation method and sediment disposal shall be handled through mechanical dewatering method, reuse the treated water	C's EMO
concrete mixing system waster water High PH and SS	Waste water with high PH and SS, polluting river	Treat by neutralized sedimentation method, and reuse or discharge	
wastewater with oil	Oil and grease pollutes the river water from equipment repair	Using oil separating tank to treat the oil water	

	workshop and automobile repair and maintenance workshop.		
Sewage	With high BOD, SS, COD, TN and TP in water	Using buried package domestic sewage equipment to treat domestic sewage	
Occupation of land	Kill the flora and disturb the habitat	Restoration of vegetations Publicity and Education landscape	O's EMO
dust	highly concentrated dusts affected people and other organism in the area	Water spraying in dry seasons	
noise	noise pollution in the construction area because of high level noise produced by the running of mechanical equipment in construction excavation, blasting, transportation, aggregate processing, concrete mixing, etc. the quarry explores will cause the level of noise because of blast	labor protection for the workers shall be strengthened; control the working time.	C's EMO
Solid waste	the domestic waste will become the hotbed of mosquitoes and rats, which will threaten population health, and the leachate may pollute soil and underground water.	collected for concentrated treatment on the domestic garbage and pile them at designated disposal areas to the spoiled materials	
Social environemnt	infectious diseases and the input and output of pathogen. outbreak and wide spread of natural focus diseases, insect-borne infectious diseases, water-borne infectious diseases, endemic diseases,	Cleaning the drinking water, disinfecting the working and living places, making the close monitoring and so on	O's EMO
	Occupy the cultivated land and so on, affecting the normal life	economic compensation	
	222 people need to relocated	Rsettlement plan	
Operation period			
sewage	Affect the water quality of river	Keep on using the buried package domestic sewage equipment in construction phases	O's EMO
Territorial ecosystem	Kill or affect the flora and fauna	Strengthen Management, prohibit them to hunt and kill wild animals	O's EMO
Aquatic ecosystem	the sphere of activity of the fishes will be limited/	Protecting the tributaries	O's EMO
Solid waste	The same as the construction period	Collecting and transporting to the disposal area	O's EMO
Reservoir inundated	Affect the water quality	Reservior cleaning	O's EMO

		Reservoir management and monitoring	O's EMO
Environmental accident	Oil will pollute the river	a public oil pond; waste oil treated through an oil-water separator shall be recovered and wastewater shall be used for watering of road, plant et	O's EMO
Social environment	Affect the local econimic	Implement the CSR	O's EMO
earthquake	Threat the dam safety	foundation treatment measures, aseismic measures, reservoir emptying measures and safety monitoring measures for dam, powerhouse and other key parts of seismic fortification.	O's EMO
flood		energy dissipation and bank mitigation measures	O's EMO
Cumulative impacts	Bad to organism	Implement biodiversity conservation plan	O's EMO
	Polluting the water	Monitoring and management	O's EMO
Local People's production and living	Disturb the environment	Implement monitoring plan	O's EMO
Environmental risk	emergent environmental incident	Write and implement contingency plans	O's EMO
Decommissioning Period			
Still using	Affect the environment	to carry out EIA newly	O's EMO
removing	Solid waste	Pile them at designated disposal areas	O's EMO
	Block the river		O's EMO
	cause impacts on the quality of local ecosystem and landscap		O's EMO

9.3 Environmental Monitoring Scheme

9.3.1 Water Environment Monitoring

(1) Water Environment Monitoring

1) Monitoring for Water Quality of River and Waste water of Construction Area

It should monitor water quality at waste water treatment outlets and river. There are 2 sections in wastewater treatment system outlet of aggregate processing system, 2 sewage outlet of construction camp areas .etc. as well as 500 meters upstream of the dam site of the Tongxinqiao HPP, 3 km downstream of the dam of the Tongxinqiao HPP and downstream to the powerhouse. The monitoring time is in the early phase of construction and the peak period.

① Monitoring purposes

To ensure that the discharging from waste water treatment facility meet the standards and monitor water quality of the river to make sure if it is deteriorated due to construction.

② Monitoring Items

There are nine indexes including SS, PH, COD, BOD_5, TN, TP, Oil and grease, anionic surfactant and fecal coliforms.etc.

③Monitoring Location and Time

Setting monitoring section during the construction period corresponding monitoring points, the time according to the requirements of routine monitoring of surface water, to montior and analysis each once in the initial period of construction and the peak period of construction.

2) Water Quality Monitoring in Operation Period

① Monitoring Purpose

Monitor the water quality of both of Tongxinqiao reservoir and the river course at the downstream reaches, timely mastering the dynamic of the water quality of the reservoir and the river course at the lower reaches as well as improving the safe reliability of the water resource utilization.

② Monitoring Item

Reservoir water quality and downstream river water quality monitoring can be delegated to monitor by the relevant agencies of Myanmar. Monitoring Items are the same as the construction phases.

③ Monitoring Location and Time

Setting monitoring section is the same as the construction period on the river and sewage treatment outlet of Owners camp. The monitoring time is at the high, normal and low flow periods in the third year after the operation. Monitor 2 times at every period.

9.3.2 Ambient Air Monitoring

1) Monitoring Purpose

It is to understand and master the dust concentration of each construction point; Monitor the

waste gas generated from rock blast, fuel firing of construction machinery; Provide baseline data for strengthening the construction security and hygiene protection and perfect the prevention and mitigation measures for atmosphere pollution caused by construction.

2) Monitoring Item

The monitoring items of the atmospheric environment quality shall be SO_2, TSP and NOx.

3) Monitoring Location and Time

The monitoring locations shall be Shengxiu village, living areas for damsie and the place beside the aggregate processing system.

The monitoring time of TSP and SO_2 shall be the the initial period and the peak period of construction. The sampling shall be carried out once respectively in the rainy and dry seasons, 2 days each time and 4 periods each day. No monitoring item need to be planned in operation period.

9.3.3 Acoustic Environment Monitoring

(1) Monitoring purpose: to understand the noise conditions for improving relevant protection.

(2) Monitoring items: Equivalent Continous A-Weighted Sound Level

(3) Monitoring location: Shengxiu Village and the two construction camps

(4) Monitoring time: monitoring shall be carried out once respectively in the initial period and the peak period of construction (divided into days and nights).

9.3.4 Population Health Monitoring

(1) Monitoring Item

According to the sanitary conditions of the local environment, during construction, key monitoring shall be applied to the infectious diseases including the insect-borne infectious disease (malaria), water-borne infectious disease (bacillary dysentery), typhoid fever, paratyphoid fever, virus hepatitis and so on.

(2) Supervising Object and Time

The main monitoring object in the construction area shall be the construction population and the monitoring time shall be from the construction commencement to its completion.

9.3.5 Terrestrial Ecology Monitoring

(1) Monitoring Purpose

Carrying out monitoring the space-time changes and the change rules of terrestrial ecosystem before and after construction of the Tongxinqiao HPP, Mastering the influence level of terrestrial ecosystem caused by the HPP construction and the effect after implementation of terrestrial ecosystem mitigation measures , so as to provide basis for terrestrial ecosystem protection and river basin environment management in the reservoir zone.

(2) Monitoring Content, Time and Location

Monitoring contents mainly include the species of flora and fauna, change trends of population and so on.

The first survey is proposed at the peak period of construction and the second survey is proposed at the third year after the operation of the HPP. And then comparison and analysis will be carried out between the results of two surveys.

Setting three sampling plots, which are located in upstream of the dam, between the dam and powerhouse and downstream of the powerhouse. The plot selection shall consider the terrestrial ecological features, which is on behalf of dynamic of impacts affected by the projects.

9.3.6 Aquatic Organism Monitoring

A detailed aquatic life investigation should be organized prior to reservoir inundation. And another detailed aquatic lift investigation should be respectively carried out in the fifth and the tenth year after reservoir inundation. The investigation scope is the water outlet from the reservoir tail of the Tongxinqiao HPP to the tail of powerhouse .

The contents of the survey include phytoplankton, zooplankton, benthonic animals and fish, etc. Focus on fish and especially species and population structure of fish.

Arrange two time of surveries. The first survey is proposed at the medium-term period of construction, and the second survey is proposed at the fifth year of operation of the HPP. And then ,comparison and analysis will be carried out between the results of the two surveys.

Monitoring locations are consistent with the points set at the baseline stage.

9.3.7 Enviromental conservation measures schedule

It is planned many measures from the preliminary stage, construction stage, operation stage to the after closing stage of the project. We design a table to show the conservation measures schedule of all mitigation measures as follows. It is table 9.3-1.

Table 9.3-1 Environmental conservation measures schedule

Item	Pr1	Pr2	Construction period			Co.	Operation period		Cl.
	1 year	1st year	2nd year	3rd year	4th year	5th year			
Water environment									
Aggregating process waste water treatment system									
Concrete processing system waste water treatment									
separating tank									
Buried package domestic sewage equipment									
Developer camp									
Contractor camp									
Reservoir water quality mitigation measures									
Reservior clearing									
ecology									
Restoration of vegetation									
Rare and endanged species protection plan									
Strengthen Management, prohibit them to hunt and kill wild animals									
Tributary , preserved forest and watershed area									
Acoustic and atmospheric									
Water spraying									
labor protection									
Solid waste									
Collected and pile them at designated disposal areas									
waste slag									
Occupation health and safety									
Cleaning the drinking water and so on									
Society									
economic compensation									
Rsettlement plan									
CSR									
Environmental monitoring									
carry out EIA newly									
Pile waste rock and concrete at disposal areas									
Emergency case schedule such as explosion, fire and earthquake									

Remark: Occupational health and safety are priority along the work schedule. Pr1. , The preparatory establishment period ; Co. , completion period

Pr2. , The preparation period ..... occational Op. , Cl. The close period

9.3.8 Investment Estimated

The environmental protection investment on the Tongxinqiao HPP is 2.0972 million US$, detaled in Table 9.3-2. Refer to for investment estimation for environmental protection.

Table 9.3-2 Investment Estimation for Environmental Protection of Tongxinqiao HPP

No.	Item	investment（10^4 US$）	Remarks
I	Water and soil conservation in construction area	98.20	
1	Engineering measures	49.10	
2	Botanical measures	32.73	
3	Temporary measures	16.37	
II	Water environmental mitigation measures	18.28	
1	Aggregate processing system	1.31	
2	Concrete mixing system	1.39	
3	Treatment of domestic sewage	13.94	
4	Treatment of oil stain and wastewater	1.64	
III	Atmosphere environment protection	4.58	
1	car	2.95	
2	Spraying for dedusting	1.64	
IV	Acoustic environment protection	3.73	
1	Slowdown and no-horn signs	0.13	
2	Safeguard on the noise	3.60	
V	Domestic garbage disposal works	8.40	
1	Rubbish can	0.05	
2	Collection center	1.64	
3	disposal	6.70	
VI	Mitigation measures for terrestrial fauna and flora	2.42	
1	Publicity and management fees	0.79	
2	Animal protection contingency	0.82	
3	Transplant of precious plant	0.82	
VII	Aquatic life mitigation measures	2.45	
1	Fishing administration,	2.45	
VIII	Population health protection	4.39	
1	Disease surveillance survey	0.98	
2	disinfection to the pool and drinking water source	2.29	
3	health declaration	0.65	
4	Preventive medicine	0.79	
IX	Environmental monitoring	57.28	
1	Water monitoring	4.09	
2	Aquatic organism monitoring	9.82	
3	Terrestrial organism monitoring	14.73	
	Sub-total	199.73	

X	Emergency fund	9.99	5%
	Total	209.72	

10 Public Participation and Information Disclosure

10.1 Objective and Significance

The purpose of public participation in environmental impact assessment of the Tongxinqiao HPP is to protect the legal environmental rights and benefits of the public, and reflect the people oriented principle in the environmental impact assessment, so as to further understand the environmental background, find out potential environmental problems and improve the scientificity and pertinence of the environmental impact assessment. Through public participation, the public can understand the current situation and existing problems of the Tongxinqiao HPP, thus mitigating the misunderstanding and bias possibly brought by asymmetrical information, putting cost-effective and feasible measures to mitigate the negative social environmental impact, balance the rights and benefits of all parties, resolve the social contradictions possibly caused by the negative environmental impact, and promote democratization and scientification.

When the two-way communication mechanism of public participation is established, the public could further understand the Tongxinqiao HPP, and confirmed the major environmental problems caused by the Tongxinqiao HPP and the feasibility of environmental mitigation measures. The attitude and comments of the public shall be taken into consideration, exerting the function of public supervision, so as to make the public thoroughly accept the Tongxinqiao HPP, increase the environmental and economic benefits of the Tongxinqiao HPP, and implement the sustainable strategy.

Public participation is an important part of environmental impact assessment. Questionnaire survey in the construction area of the HPP will help to provide construction information of the HPP to the population and organizations subject to impact of the HPP construction on one hand, especially the issues closely related to their daily lives and production, and to obtain their support and assist, as well as to exert the comprehensive and long-term benefits of the HPP construction to a maximum extent; on the other hand, it helps the evaluation organizations to understand the attitude, cared issues and requirements of the population and organizations subject to impact of the HPP construction for the hydropower development. Make the environmental impact assessment fuller and more accurate, of great advantage of improving the quality of overall environmental impact assessment of the hydropower construction, thus formulating environmental mitigation measures of greater pertinence and operability. Sociologically speaking, "Public Participation" refers to the purposeful social

activities in which the social masses, social organizations, units or individuals participated within their scope of rights and obligations. "The Public" refers to one or more natural or legal person, for example, the definition of "the Public" in the Public Participation by the World Bank refers to the population subject to direct impact, public representatives of units and groups subject to the impact, and other groups who are interested.

10.2 Organization Mode of Public Participation

Household survey and questionnaire survey are carried out for the environmental impact assessment and social impact assessment of the Tongxinqiao HPP construction.

YPIC International Energy Cooperation & Development Co., Ltd. (hereinafter referred to as YPIC) is responsible for overall coordination of the survey. Under the overall organization and coordination of the DHPI, the YPIC, the IGE, the KHIDI, the REM and relevant local governments in Myanmar constitute the joint survey team together, in order to carry out the relevant onsite jobs. The work division of the parties is as follows:

(1) DHPI

The DHPI is responsible for coordinating and organizing personnel of local governments at various levels to participate in the survey, and is responsible for communicating with and coordinating the armed forces or organizations and local government in the survey area.

(2) YPIC

As the Employer of the HPP, it is responsible for organizing and participating in the design, studying the major issues encountered in design with relevant parties, coordinating the relationship among the parties, and participating in the survey.

(3) IGE

It is responsible to provide translation coordination between the government (DHPI, local government) and Chinese personnel (the YPIC and KHIDI), and participate in the survey.

(4) KHIDI

It is responsible to undertake the detailed preparation of environmental impact assessment of the Tongxinqiao HPP construction.

(5) REM

It is responsible for the survey related to the environmental impact assessment and social impact assessment and intention survey of resettlement, collecting various statistical data in the involved areas, participating in the survey and providing relevant results.

(6) Relevant Local Governments in Myanmar

Relevant local governments in the Myanmar are responsible for the participation, organization, coordination and cooperation.

10.3 Survey Process

(1) In December 2013, the KHIDI entrusted the REM to carry out the survey and relevant tasks of environmental impact assessment and social impact assessment of the Tongxinqiao HPP.

(2) From February 26, 2014 to March 8 of the same year, under the assistance of the YPIC and the organization of the DHPI, the DHPI, the YPIC, the IGE, the REM, and the KHIDI constituted the survey team together, developing the field survey of construction of the Tongxinqiao HPP as well as the public participation survey.

10.4 Survey Mode

10.4.1 Publicity

(1) Poster

According to the current survey results, only 16% of interviewees know the HPP and only about half of these interviewees know of the HPP from the the project proponent or their colleagues. It means that disclosure of relevant information about the HPP to the public is very urgent and necessary. The REM made many posters (as shown in Figure 10.4-1) and posted them in each village along the river valley, in order to inform the public of the information ranging from the the project proponent to the HPP and the environment impact of the HPP construction.

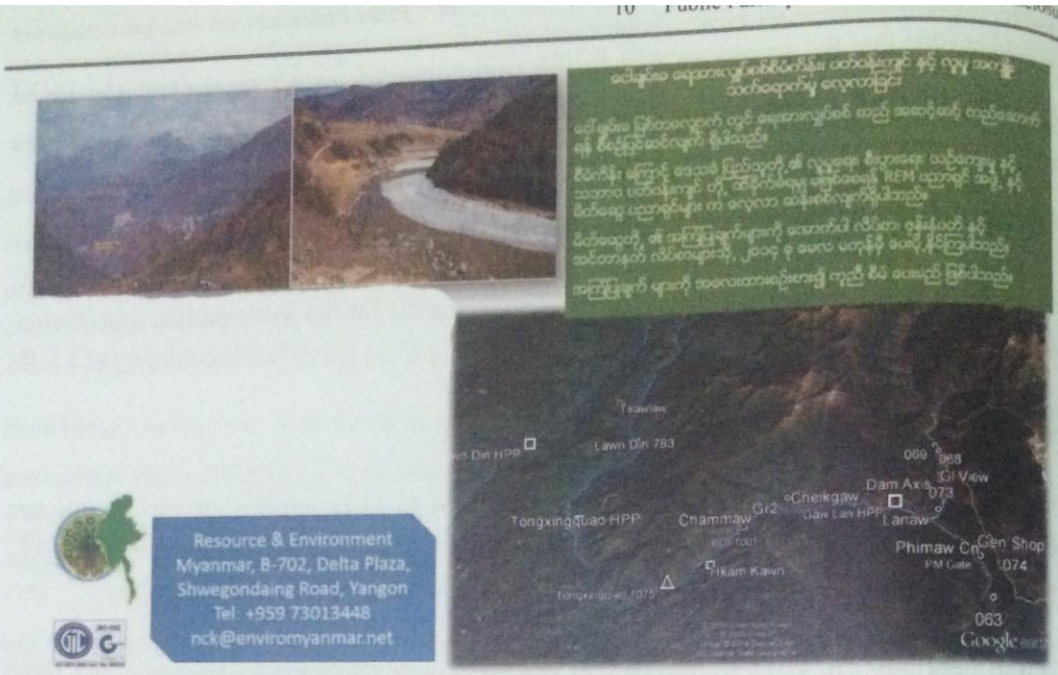


Figure 10.4-1 Posters Provided in 15 Villages along the

Ngaw Chang Hka River Basin (2014.11.3)

(2) Publicity in newspapers

REM held an announcement in the meeting room of Chibwe Town Government, mainly introduced hydropower developments, favorable and unfavorable environmental impacts of Ngaw Chang Hka River, answered the questions of everybody one by one, and donated personal computers to the local school. The local newspaper reported the event. The publicity in newspaper may be referred to Figure 10.4-2.

Implementation of hydropower project discussed

MYITKYINA, 24 May— Resource and Environment Myanmar Co., held a discussion on implementation of Ngawchankha hydropower project at the hall of Chipwe Township General Administration Department on Friday.

Environmentalist Dr Win Maw and Social-environmentalist Daw Khin Ohnma Htwe explained advantages and disadvantages in implementation of the hydropower project and replied to queries.

At the ceremony, the company donated one set each of computer for Chipwe Basic Education High School and Nozunbaung BEPS, amounting to K 600,000.

Myitkyina District (IPRD)

Figure 10.4-2 Screenshot from local newspaper (2014.5)

10.4.2 Household Survey and Symposium

During the survey, relevant data were obtained by visiting the local residents, and at the same time, the resettlement intention was also surveyed. The survey personnel discussed with the village head and part of the villager representatives, understanding the local social and economic conditions. By approaching negotiations with project Impact, mitigation measures, implementation main part, sources of funds, Money Management, responsibilities, etc. The symposium was held in affected regions. The participants included directly affected people and indirect affected people, especially the poor households, the minority nationalities, and the female representation. In-depth interviews was conducted with randomly affected community and resettlement area. The survey process is as shown in Figure 10.4-3.

In affected community and resettlement area, the social factors, project stakeholders, development willingness, sustainable development, mitigation measures, development practices, implementation main part of measures, and related matter of duty were discussed and consult by the project proponent, affected people, local government officials. Meeting minutes were completed ultimately.

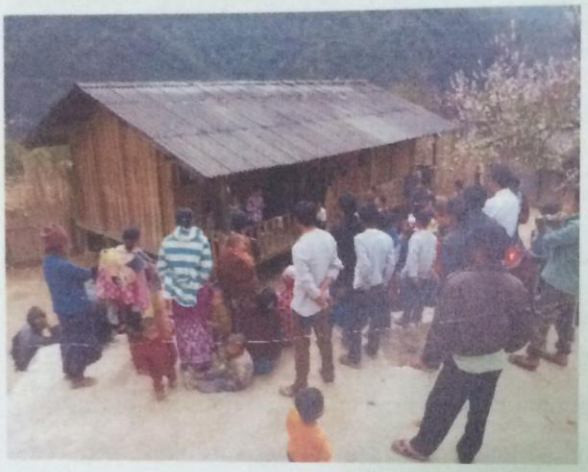


Figure 10.4-3 Survey photos

10.4.3 Questionnaire Survey

The questionnaire survey was carried out in the village and immigrants arrangement areas, affected by project construction. The samples covered main stakeholder with different types with special attention to the directly environmental influences people. In order to obtain the impact of psychological and social relationships of the local residents by the HPP construction, the in-depth interview was held for the residents who were affected severely. At the same time, questionnaires survey were distributed to the involved villagers to fill out. Refer to Figure 10.4-5 and Figure 10.4-5 for details. Part of all questionnaires are presented in Appendix 3.

Figure 10.4-4 working photos in Lon Pan village

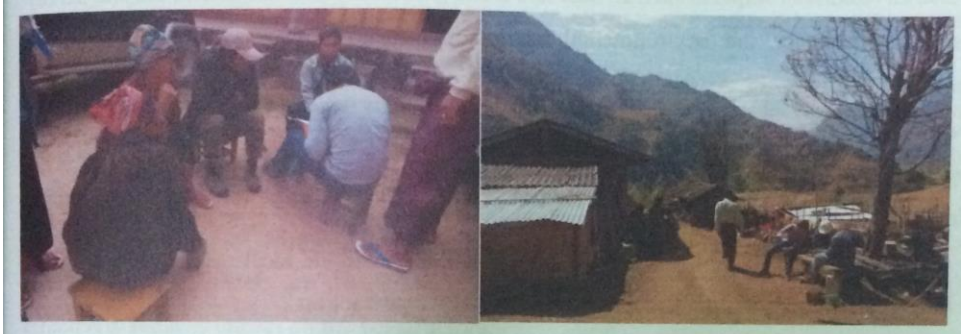


Figure 10.4-5 working photos in Ve lat village

10.5 Survey Results

(1) The first time survey result

In total, 2 villages with about 41 persons as the survey object participated in the survey. Only 16% of the interviewees know that the HPP construction is to be developed in the basin, mainly through the local governments, public media, neighbors and development personnel entering the local place for the preliminary works. In addition, 70% of the interviewees support or are very glad to support the HPP. These interviewees suppose that the HPP basically will not bring about any adverse environmental impacts while other interviewees suppose that there may be some adverse environmental impacts. The interviewees from Ve lat Village suppose that the agriculture will be impacted severely and more than 91% of the interviewees suppose that development of the HPP will bring about slight impact on the society and population health. The masses' main comments are as follows: after the HPP is safely completed, the HPP can properly serve the villages around and provide them with good services in terms of electricity, medical treatment and traffic; meanwhile, they worry about

that the HPP construction will bring about adverse impacts on the local agriculture, mainly referring to reservoir inundation and paddy fields and lands occupied by construction, which may affect the agricultural production; in addition, they also worry about that dust generated by construction transportation will affect their respiratory systems; furthermore, a great quantity of foreign constructors will make them feel unsafe.

During the site survey, medical staffs of the survey team, free of charge, carried out the diagnosis and treat for the local villagers. For all the worries and demands proposed by the villagers, the site survey personnel introduced the HPP to the villagers in details. For the adverse environment impacts such as dust and noise generated by construction, the site survey personnel introduced the environmental mitigation measures of the HPP construction in details. For the impact on the walnut trees and paddy fields brought about by the lands occupied by construction, the site survey personnel informed the villagers that the the project proponent will negotiate with the local governments prior to construction commencement, in order to reach an agreement on compensation for the villagers, such as the compensation for the cultivated lands. All of the above measures will eliminate the local residents' worries on the impact on their agricultural production by the HPP construction.

(2) The return visit and relevant works

After the first time survey, the developer carried out many work to let the stakeholder know, understand and support the construction of the Project. The relevant document is seen Appendix 7.

11 Conclusions and Recommendations

(1) Conclusions

The Tongxinqiao HPP is a hydropower resources development project encouraged by the Republic of the Union of Myanmar; its construction is consistent with industry policy and is important for boosting economic development of poverty-stricken area.

However, there are some adverse impacts in the construction period, mainly including the aspects as follows. Reservoir inundation and construction land acquisition will cause damage to vegetation and animal and plant resources. The habitat of fishes are fragmentation and the flow velocity is slower in U/S reaches of river. "Three Wastes (waste gas, wastewater, solid waste)" and noise pollution will occur during construction; water and soil loss will be caused by construction disturbance on earth surface.

As to the above-mentioned adverse impacts, measures for vegetation compensation and restoration and fish protection and management are planned in the environmental protection design, so to minimize various kinds of adverse impacts of the Project on the ecosystem as far as possible; prevention measures for Three Wastes and noise pollution during construction are also prepared; pollutants are discharged in line with standard during construction and this effectively reduces impact on the constructors.

The project construction of the Tongxinqiao HPP is not associated with the environmentally sensitive area defined by the Republic of the Union of Myanmar and local government. The project construction is free from restrictive sensitive factors, and the adverse impacts from the project construction can be accepted with practical implementation of various environmental mitigation measures and suggestions in the Report. As a result, the construction of the Tongxinqiao HPP is feasible on the basis of analysis of environmental protection.

(2) Recommendations

It is suggested to timely conduct design for environmental mitigation measures in combination with the actual progress of the project, conduct thorough studies and detailed design of the environmental mitigation measures, strictly follow the system of "three spontaneities", make available the corresponding costs, so as to mitigate the adverse impacts, and ensure implementation of various environmental mitigation measures.

To the various construction and development activities of the project, it is necessary to be highly careful about the environmental protection work, reinforce environmental management during the construction period, and implement environmental management and monitoring.

THE REPUBLIC OF THE GOVERNMENT OF THE UNION OF MYANMAR
MINISTRY OF ELECTRIC POWER
DEPARTMENT OF HYDROPOWER PLANNING
BUILDING NO. (27) NAY PYI TAW

ax: 95-67-410510
Phone : 95-67-410407

Letter No. 0885 /YPIC/DHPP/ 2013
Date. 28 June, 2013

o
Mr. KANG Jin
Managing Director
YPIC International Energy Cooperation & Development Co., Ltd.
Fax: (00 86-871-68309866)

ubject : **Work Application Plan for EIA and SIA of Ngaw Chang Hka Hydropower Projects**

eference: YPIC International's Letter No. YPIC (2013)-NCK-03 dated: 7th June, 2013

ear Mr. KANG Jin,

First of all, I would like to express my sincere gratitude to you and your esteemed ompany, YPIC International Energy Cooperation & Development Co., Ltd. (YPIC nternational) for your persistent cooperation in developing Ngaw Chang Hka ydropower Projects. Regarding the captioned subject, Ministry of Electric Power MOEP) agrees YPIC International's proposal to establish a work team with Hydrochina unming Engineering Corporation (KHIDI) and Resource and Environment Consultant ompany of Myanmar (REM) for carrying out EIA and SIA works of Ngaw Chang Hka ydropower Projects. Concerning with the security for site investigation works, you should irectly submit the detailed schedule to Department of Hydropower Implementation DHPI) through No. 5 Construction Bureau three weeks in advance.

Your further cooperation will be highly appreciated.

Yours sincerely,

(U Phone Myint)
Acting Director General

C. (1) Ministry of Electric Power
(2) Department of Hydropower Implementation
(3) International Group of Entrepreneurs Company Limited
(4) Office Copy

Field And Working Photos

Loc. No. 040 25.93254N 98.38986E

0.5ft Light Grey sandy Soil

2ft Yellowish sandy Soil

2ft Yellowish Gravel sandy soil

1.5ft Massive porphyritic Granite With quartz veins

Scale: 1in =1ft

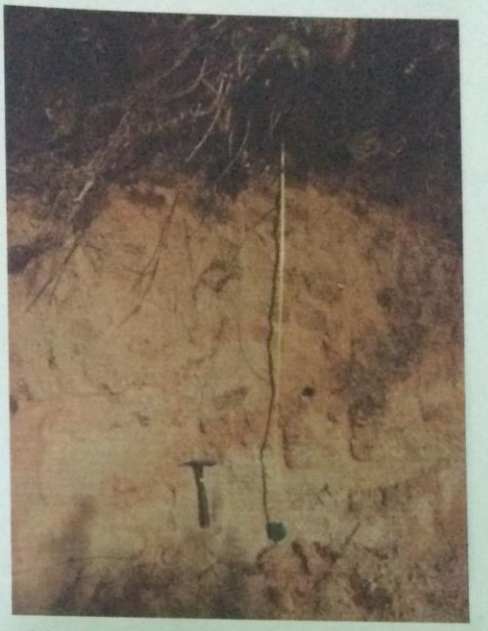


Figure 1 Soil profile of the Tongxingqiao area

Loc. No. 050 25.99955N 98.40986 E

3ft Light Grey Gravel

11ft Gravel, Quartz angular fragments

2ft Deposited zone Black-Brownish-Reddish

4ft Pebbly Layered Light Grey Sand Q2

Scale: 1in = 4ft

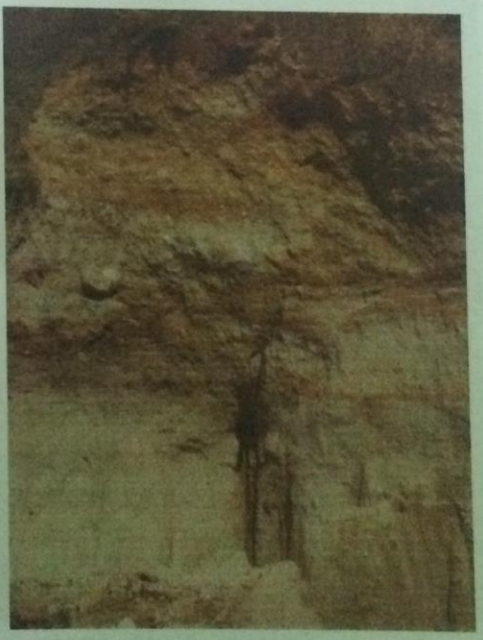


Figure 2 Soil profile of the Tongxingqiao area

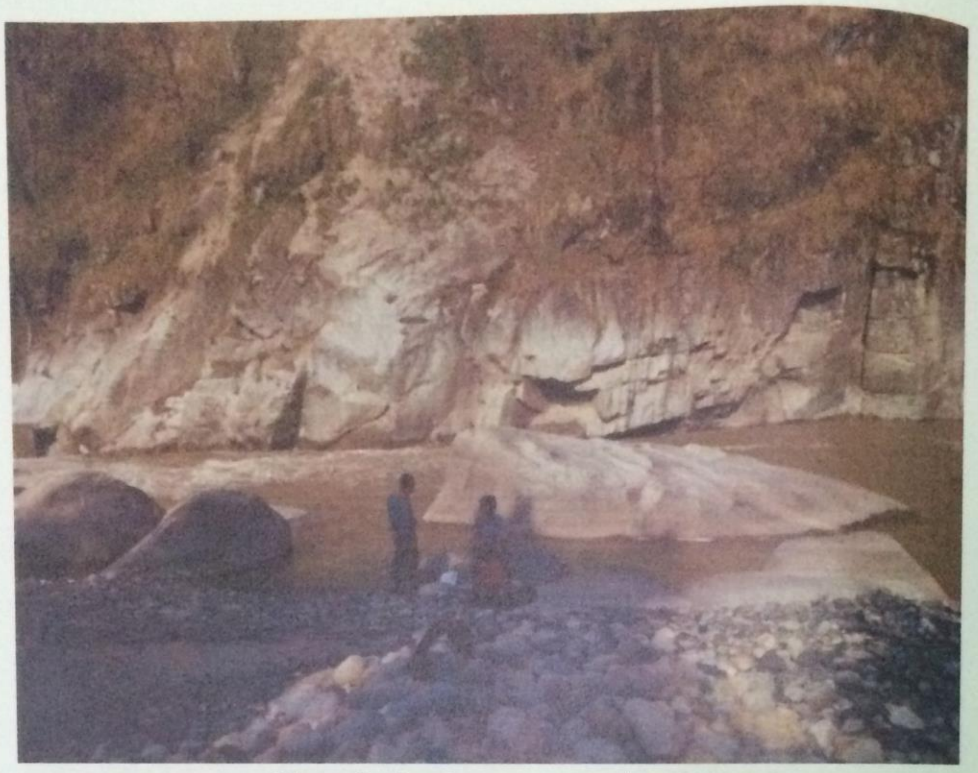


Figure 3 Granite exposure at dam site

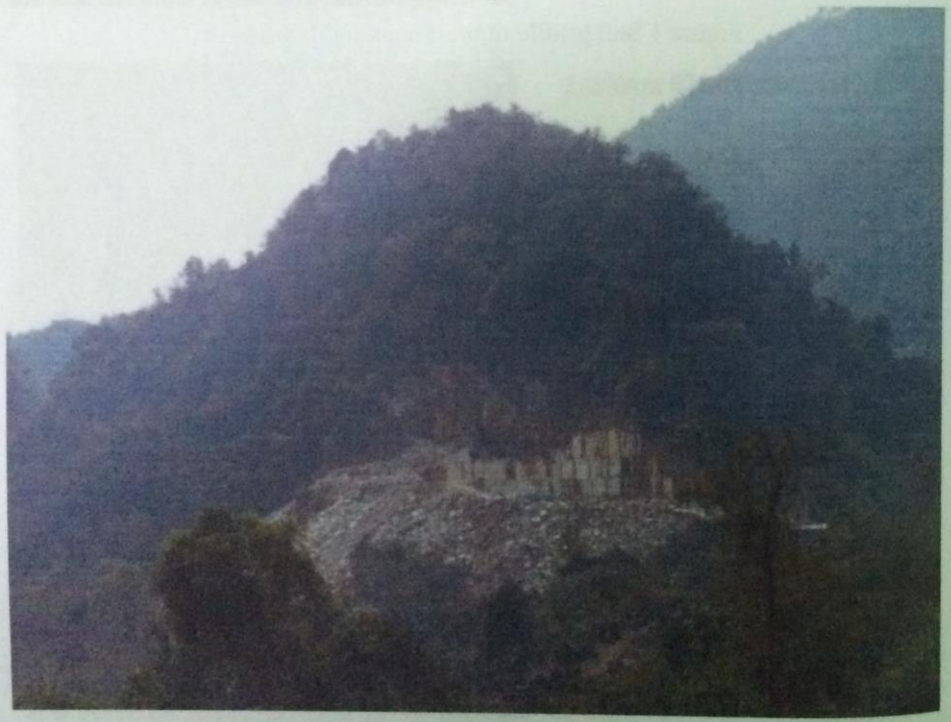


Figure 4 Marble exposure near power house area

Figure 5 the alluvium deposit (Q1) near Ba-let village

Figure 6 Location of gas emission and noise monitoring at NSW-5

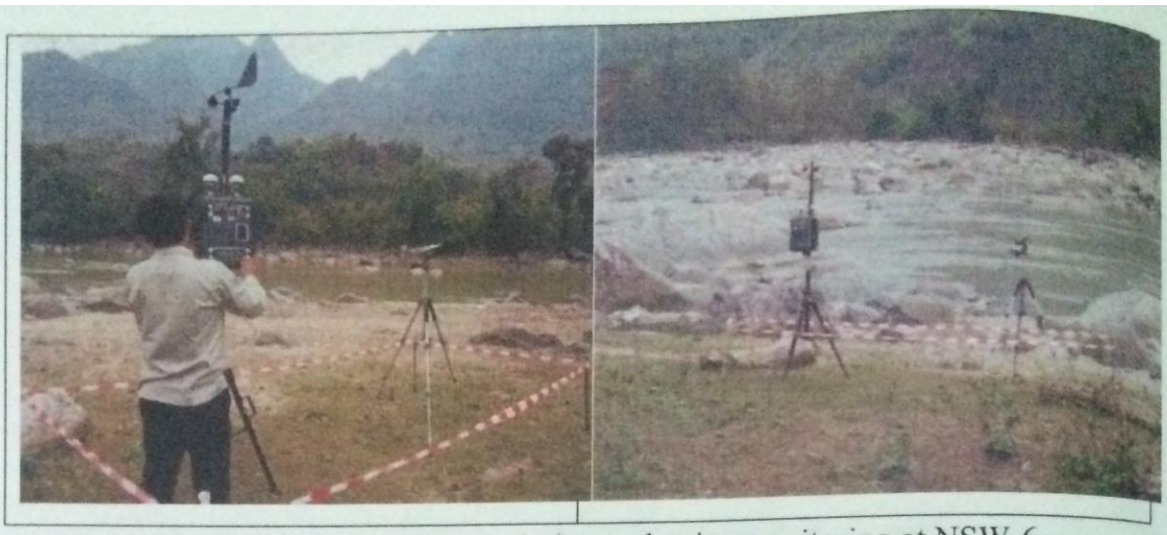


Figure 7 Location of gas emission and noise monitoring at NSW-6

Figure 8 Location of Water Sampling at NSW-8

Figure 9 Location of Water Sampling at NSW-9

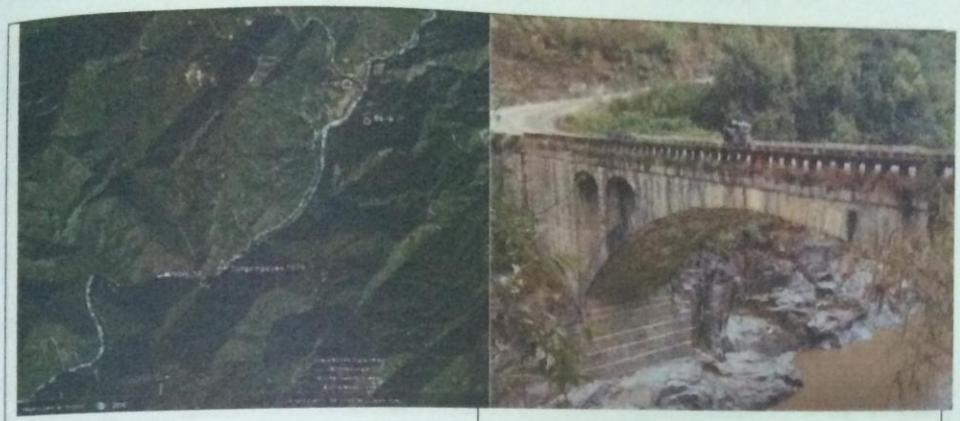


Figure 10 Location of Water Sampling at NSW-10

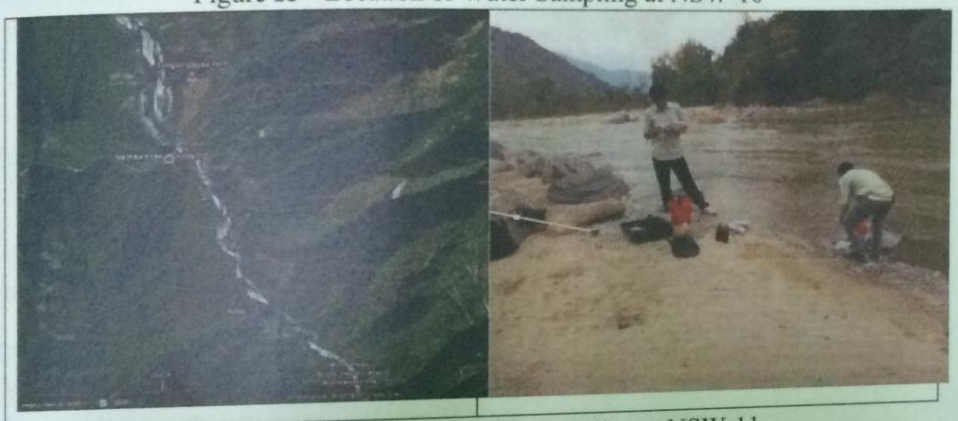


Figure 11 Location of Water Sampling at NSW-11

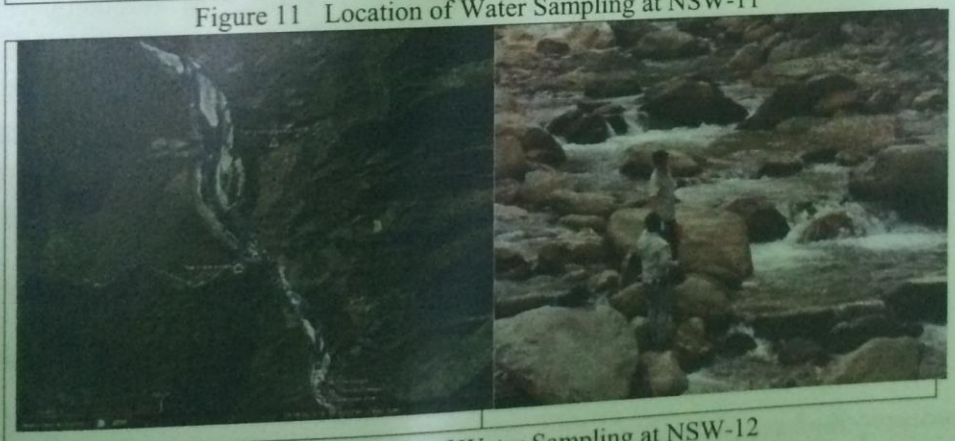


Figure 12 Location of Water Sampling at NSW-12

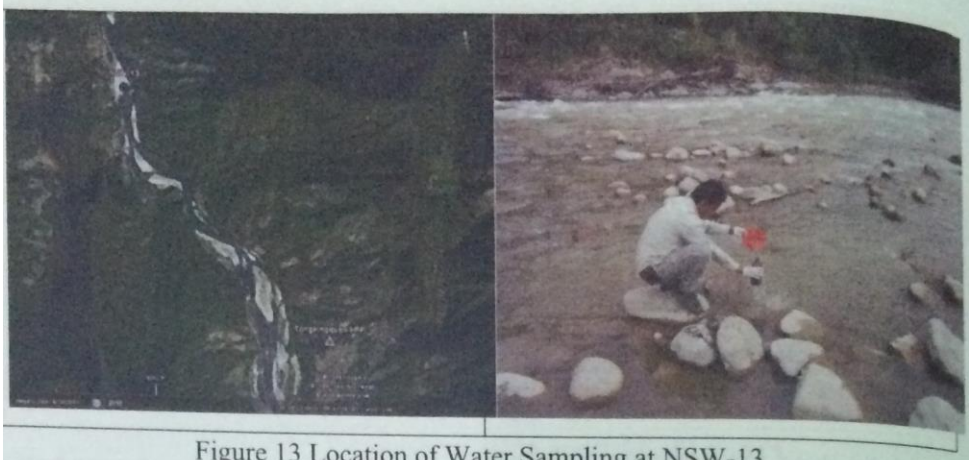


Figure 13 Location of Water Sampling at NSW-13

8 (1) LP X

QUESTIONNAIRE FOR SOCIAL IMPACT ASSESSMENT OF NGAW CHANG HKA HYDRO POWER PROJECT

No .... Date of interview........................ Name of interviewee.....[illegible].........

Part A Interviewee information (ဖြေဆိုသူ၏အချက်အလက်များ)

A.1. Sex (ကျား/မ) ☐ 1) Male (ကျား) ☐ 2) Female (မ) — circled: 2

A.2. Age (Years) (အသက်/နှစ်) (50)နှစ်

A.3. Religion (ဘာသာ) ☐ 1) Buddhism ☐ 2) Christianity ☐ 3) Others (please specify) ... — circled: 2

A.4. Marital status (အိမ်ထောင်ရှိ/မရှိ)

- ☐ 1) Single (လူလွတ်)
- ☐ 2) Married (အိမ်ထောင်ရှိ) — circled
- ☐ 3) Widowed(မုဆိုးမ)
- ☐ 4) Divorced (ကွာရှင်းထားသူ)

A.5. Level of education(ပညာအရည်အချင်း)

- ☐ 1) No schooling (ကျောင်းမတက်ဘူးသူ) — circled
- ☐ 2) Primary school (မူလတန်း)
- ☐ 3) Middle school (အလယ်တန်း)
- ☐ 4) High school (အသက်မွေးပညာသင်ကျောင်း)
- ☐ 5) Bachelor Degree (ဘွဲ့ရ)
- ☐ 6) Monastic (ဘုန်းကြီးကျောင်း)

A.6. Occupation (အလုပ်အကိုင်)

- ☐ 1) Unemployed (အလုပ်မရှိသူ)
- ☐ 2) Civil service(အစိုးရဝန်ထမ်း)
- ☐ 3) Agricultural (စိုက်ပျိုးရေး) — circled
- ☐ 4) Fisherman (ငါးဖမ်းသမား)
- ☐ 5) Employed (လခစား)
- ☐ 6) Business(စီးပွားရေးလုပ်သူ)
- ☐ 7) Others (အခြား)..

A.7. Race/Indigenous/Family (လူမျိုးစု၊ မျိုးရိုးအမည်)

1) Indigenous Race (လူမျိုးစု) ____[illegible]____

2) Family (မျိုးရိုးအမည်/မိသားစုအမည် သီးခြားရှိပါက) ____[illegible]____

Part B Household information (အိမ်ထောင်စု၏အချက်အလက်များ)

B.1. Please give us some brief information about your family: မိသားစုအရေအတွက်

ကျား (၁) မ(၁) စုစုပေါင်း (၂)ယောက်

B.2. Now, what type of living standards is your household in? (အိမ်ထောင်စု၏လူနေမှုအဆင့်)

1. Poor (ဆင်းရဲ) 2. Normal (အလယ်အလတ်) 3. Well-off (ချမ်းသာ) — circled: 2

B.3. Please let me know your household income sources per year? (မိသားစု၏တစ်နှစ်ဝင်ငွေ) ____640000____ (Kyat) [illegible]

[illegible] Income sources (ဝင်ငွေရရှိသောနေရာ)

B.4. Please inform your household monthly expenses? (လစဉ်ကုန်ကျငွေ)

____80000____ kyats အဓိကကုန်ကျမှု ____[illegible]____

500[illegible]

B.5. What is your household house ownership: (အိမ်ပိုင်ဆိုင်မှု)

(1.) Owned (အိမ်ပိုင်) 2. Rented (အိမ်ငှား)

B.6. အိမ်အမျိုးအစား - အခင်း/အကာ ---------- အမိုး ----------

ဆောက်လုပ်ထားသောပစ္စည်း---------- အိမ်သက်( ) နှစ်

ယခုနေရာတွင်နေထိုင်သောသက်တမ်း( ) နှစ် (သို့) ဈေးတို

B.7. Your HH land: (မြေယာပိုင်ဆိုင်မှု)

Residential Land (လူနေအိမ်မြေ).....acres

Agricultural land (စိုက်ပျိုးမြေ).....acres

B.8 စိမ်ကိန်းနှင့်ပတ်သက်သော မြေယာအငြင်းပွားမှုရှိပါသလား။ ရှိ / (မရှိ)

ရှိပါက အဘယ်ကြောင့်နည်း ----------

မရှိပါက အဘယ်ကြောင့်နည်း ----------

B.9 စိမ်ကိန်းမှ မြေယာနှင့်ပတ်သက်ပြီး မည်သို့ဖြေရှင်းပေးသနည်း။ ----------

B.10 ဖြေရှင်းချက်အပေါ် ကျေနပ်မှု ရှိပါသလား။ ရှိ / (မရှိ)

ရှိပါက အဘယ်ကြောင့်နည်း ----------

မရှိပါက အဘယ်ကြောင့်နည်း ----------

B.11 မြေယာနှင့်ပတ်သက်သော အကြံပေးချက်ရှိပါက ----------

B.12. ငံ့ချမ်းခရောင်းရောသည် ယခင်နှင့်ယခုကွာခြားမှုရှိပါလား။ (ရှိ) / မရှိ

မရှိပါက ----------

ရှိပါက ----------

B.13. ငံ့ချမ်းခရောင်းရောစည်းမှုကြောင့်ကျန်းမာရေးထိခိုက်မည်ထင်ပါသလား။

မထင်ပါက အဘယ်ကြောင့်နည်း ----------

ထင်ပါကမည်သို့ဆိုသည်ပြောပြပေးပါ ----------

B.14. ငံ့ချမ်းခရောင်းသည် ရေလုံမှုရှိပါသလား (ရှိ) / မရှိ

မည်သည့်လတွင်ဖြစ်သနည်း။ ----------

Part C Transportation/Movement information (လမ်းပန်းဆက်သွယ်ရေးအချက်အလက်များ)

C.1. မည်သည့်မြို့သို့သွားဘူးသနည်း။

---------- ( )သွားဘူးသောအကြိမ်

C.2. Which purposes do your household members uses the alignment for?

(သွားရောက်သောရည်ရွယ်ချက်)

C.3. How is your present transportation state in your community?

(လက်ရှိလမ်းပန်းဆက်သွယ်ရေးအပေါ်ထင်မြင်ချက်)

1. Good (ကောင်း) 2. Normal(ပုံမှန်) (3)Bad (ညံ့)

Part D Opinions upon the Project (စီမံကိန်းပေါ်ထားရှိသောသဘောထားထင်မြင်ချက်)

D.1.Have you heard about the NCK Hydro Power Project? (သိ/မသိ)

(☐ 1)) No (မသိ)   ☐ 2) Yes (သိရှိ)

D.2. From question D.1, if you answer Yes, how do you know the project? (သိရှိပါက)

☐ 1) Informed by authority (အစိုးရထံမှ)
☐ 2) Informed by neighbors (အိမ်နီးနားချင်းထံမှ)
☐ 3) Informed by media (မီဒီယာများ၊သတင်းစာ၊ဂျာနယ်၊ရေဒီယိုမှသိ)
☐ 4) Informed by Company (ကုမ္ပဏီမှသိ)

D.3. What are your concerns during the project?
(စီမံကိန်းနှင့်ပတ်သက်သော စိုးရိမ်မှု၊ ထင်မြင်ချက်)

Item(အမျိုးအစား)	0 (No) (မကြိုက်)	1 (Less) (သိပ်မကြိုက်)	2 (Normal) (သာမာန်)	3 (Yes) (ကြိုက်)	4 (Very) (အလွန်ကြိုက်)
Overview (အမြင်)	✓				

If No, Why don't you like this project? (စီမံကိန်းအပေါ် မနှစ်သက်ပါက အကြောင်းပြဖြေဆိုပါရန်)
လယ်ယာမြေ ရေ [illegible]

If Yes, Why do you like this project?

D.4.Do you feel worried about environmental impact during operational phase of the project?
(စီမံကိန်းနှင့်ပတ်သက်သောပတ်ဝန်းကျင်ဆိုင်ရာအကျိုးသက်ရောက်မှုအပေါ်စိုးရိမ်မှု)
(1.) No, specify မရှိပါ
2. Yes, specify

D.5.Do you feel worried about social impact during operational phase of the project?
(စီမံကိန်းနှင့်ပတ်သက်သောလူမှုဆိုင်ရာအကျိုးသက်ရောက်မှုအပေါ်စိုးရိမ်မှု)
(1.) No, specify မရှိပါ
2. Yes, specify

D.6.Do you feel worried about health impact during operational phase of the project?
(စီမံကိန်းနှင့်ပတ်သက်သောကျန်းမာရေးဆိုင်ရာအကျိုးသက်ရောက်မှုအပေါ်စိုးရိမ်မှု)
(1.) No, specify မရှိပါ
2. Yes, specify

D.7.Do you feel worried about agricultural impact during operational phase of the project?
(စီမံကိန်းနှင့်ပတ်သက်သောစိုက်ပျိုးရေးဆိုင်ရာအကျိုးသက်ရောက်မှုအပေါ်စိုးရိမ်မှု)
(1.) No, specify မရှိပါ
2. Yes, specify

D.8. Opinion and Suggestion toward the project Development မရှိပါ

QUESTIONNAIRE FOR HEALTH IMPACT ASSESSMENT OF NGAW CHANG HKA HYDRO POWER PROJECT

ဤမေးခွန်းလွှာသည် ငေါ့ချမ်းခ ရေအားလျှပ်စစ်စီမံကိန်း ပတ်ဝန်းကျင်ကျေးရွာများရှိရွာသူ/သားများ၏ကျန်းမာရေး အခြေအနေများကိုလေ့လာဆန်းစစ်သောမေးခွန်းလွှာဖြစ်ပါသည်။ကူညီဖြေကြားပေးပါရန်မေတ္တာရပ်ခံအပ်ပါသည်။

A.1. ဖြေဆိုသူအမည် ------[illegible]------

A.2. ကျား / (မ)

A.3. အသက် (50)နှစ်

A.4. ဘာသာ ☐ ၁.ဗုဒ္ဓဘာသာ ☐ (၂.)ခရစ်ယာန်ဘာသာ ☐ ၃. အခြား

A.5. မိသားစုအရေအတွက် (၂)ယောက်☐

A.6. အိမ်ပိုင်ဆိုင်မှု (1) (အိမ်ပိုင်) 2. (အိမ်ငှား)------

A.7. အိမ်အမျိုးအစား - အခင်း/အကာ ------[illegible]------ အမိုး ---[illegible]---

ဆောက်လုပ်ထားသောပစ္စည်း------[illegible]------အိမ်သက်တမ်း(1)နှစ်

ယခုနေရာတွင်နေထိုင်သောသက်တမ်း(50)နှစ် (သို့) အတိ [illegible]

B.1. နယ်စပ်ကျော်ဖြတ်၍အလုပ်လုပ်သူရှိပါသလား။ ရှိ / (မရှိ) ( )ယောက်

B.2. အလုပ်အကိုင် ------[illegible]------

(မိသားစုတစ်နှစ်ဝင်ငွေ)------640000------ ကျပ် (ဝင်ငွေရရှိသောနေရာ) ---[illegible]---

C.1. သင်၏နေအိမ်တွင် လွန်ခဲ့သော(၆)လအတွင်းရောဂါဖြစ်ဘူးသူရှိပါသလား။ (ရှိ) / မရှိ

ရှိပါက မည်သည့်ရောဂါနည်း ------[illegible]------

C.2. မကျန်းမာပါကမည်သည့်နေရာသို့သွားရောက်ကုသသနည်း။------[illegible]------

မည်သူနှင့်ပြသကုသပါသနည်း။----[illegible]

C.3. သင်၏နေထိုင်ရာနေရာတွင် ( )ပြင်ပဆေးခန်း (ခ)အစိုးရဆေးပေးခန်း (ဂ)အစိုးရဆေးရုံ (ဃ)အခြား [illegible]

C.4. သင်နေထိုင်ရာနေရာတွင် အခြားလူမှုရေးအဖွဲ့များလာရောက်ဆေးကုသပေးပါသလား။ ကု / (မကု)

အဖွဲ့အစည်းအမည်နှင့်ကုသနည်းကို ------×------

D.1 သင်သည်အောက်ပါတို့ကိုသုံးစွဲပါသလား။

သုံးစွဲသည် / မသုံးပါ။

(က)ဆေးလိပ်သောက်ခြင်း ((ခ))ဘီယာ/အရက် (ဂ)စိတ်ကြွဆေး/မူးယစ်ဆေး

D.2.သောက်သုံးရေကိုမည်သည့်နေရာမှရရှိသနည်း။---[illegible]---

မည်သည့်ရေကိုသောက်သနည်း။------"------

မည်သို့သောက်သုံးသနည်း။ ((က))ရိုးရိုးရေ (ခ)ကျိုချက်ရေ

D.3. အသုံးပြုသောအိမ်သာ

(က)မရှိပါ (ခ)ယင်လုံ ((ဂ))ယင်မလုံ (ဃ)တောထိုင်သည်

D.4. အမှိုက်များကိုမည်သို့စွန့်ပစ်သနည်း။မည်သို့လုပ်ဆောင်သနည်း။ ---[illegible]---

E. အခြားပြောလိုသောအချက်များရှိပါကပြောပြပေးပါ။------[illegible]------

ကျေးဇူးအထူးတင်ရှိပါသည်။

Assessment Done By Interviewer Only

Serial №---1---
Village Tract---Lone Lon---
Name of Interviewer---Dr. Ye' Naing---

Social economic status	Satisfactory	Unsatisfactory	No Comment
• Education		✓	
• Income		✓	
• Housing	✓		
• Employment	✓		
• Transport		✓	
• Recreation Activity		✓	
• Media		✓	
Population affected	**Risk Present**	**Risk Absent**	**No Comment**
• Under 5		✓	
• Old age		✓	
• Family structure		✓	
• Chronically ill		✓	
• Disables		✓	
Life Style	**Satisfactory**	**Unsatisfactory**	**No Comment**
• Diet	✓		
• Alcohol, tobacco, substance abuse		✓	
• Safe sex behavior			✓
Health care services	**Satisfactory**	**Unsatisfactory**	**No Comment**
• Treatment seeking behavior		✓	
• Health care facilities		✓	
Physical environment	**Satisfactory**	**Unsatisfactory**	**No Comment**
• Water supply	✓		
• Excreta disposal		✓	
• Refuse Disposal	✓		
• Natural Disaster		✓	
• Vectors		✓	
• Vocational Dependency		✓	

QUESTIONNAIRE FOR SOCIAL IMPACT ASSESSMENT OF NGAW CHANG HKA HYDRO POWER PROJECT

No .... Date of interview....6.3.14.......... Name of interviewee..........................

Part A Interviewee information (ဖြေဆိုသူ၏အချက်အလက်များ)

A.1. Sex (ကျား/မ) ☑ 1) Male (ကျား) ☐ 2) Female (မ)

A.2. Age (Years) (အသက်/နှစ်) (70)နှစ်

A.3. Religion (ဘာသာ) ☐ 1) Buddhism ☑ 2) Christianity ☐ 3) Others (please specify)...

A.4. Marital status (အိမ်ထောင်ရှိ/မရှိ)

☐ 1) Single (လူလွတ်) ☐ 2) Married (အိမ်ထောင်ရှိ)
☐ 3) Widowed(မုဆိုးမ) ☐ 4) Divorced (ကွာရှင်းထားသူ)

A.5. Level of education(ပညာအရည်အချင်း)

☐ 1) No schooling (ကျောင်းမတက်ဘူးသူ) ☑ 2) Primary school (မူလတန်း) ☐ 3) Middle school (အလယ်တန်း)
☐ 4) High school (အသက်မွေးပညာသင်ကျောင်း) ☐ 5) Bachelor Degree (ဘွဲ့ရ) ☐ 6) Monastic (ဘုန်းကြီးကျောင်း)

A.6. Occupation (အလုပ်အကိုင်)

☐ 1) Unemployed (အလုပ်မရှိသူ) ☐ 2) Civil service(အစိုးရဝန်ထမ်း)
☑ 3) Agricultural (စိုက်ပျိုးရေး) ☐ 4) Fisherman (ငါးဖမ်းသမား)
☐ 5) Employed (လခစား) ☐ 6) Business(စီးပွားရေးလုပ်သူ)
☐ 7) Others (အခြား)...

A.7. Race/Indigenous/Family (လူမျိုးစု၊ မျိုးရိုးအမည်)

1) Indigenous Race (လူမျိုးစု) ......[illegible]......
2) Family (မျိုးရိုးအမည်/မိသားစုအမည် သီးခြားရှိပါက) ......[illegible]......

Part B Household information (အိမ်ထောင်စု၏အချက်အလက်များ)

B.1. Please give us some brief information about your family: မိသားစုအရေအတွက်
ကျား (4) မ (2) စုစုပေါင်း (6)ယောက်

B.2. Now, what type of living standards is your household in? (အိမ်ထောင်စု၏လူနေမှုအဆင့်)
☑ 1. Poor (ဆင်းရဲ) 2. Normal (အလယ်အလတ်) 3. Well-off (ချမ်းသာ)

B.3. Please let me know your household income sources per year? (မိသားစု၏တစ်နှစ်ဝင်ငွေ)
......[illegible]......Income sources (ဝင်ငွေရရှိသောနေရာ) ...480000... (Kyat) [illegible]

B.4. Please inform your household monthly expenses? (လစဉ်ကုန်ကျငွေ)
...[illegible] 80000... kyats အဓိကကုန်ကျမှု ......[illegible]......

B.5. **What is your household house ownership:** (အိမ်ပိုင်ဆိုင်မှု)
✓1. Owned (အိမ်ပိုင်) 2. Rented (အိမ်ငှား)

B.6. အိမ်အမျိုးအစား - အခင်း/အကာ ---------- အမိုး ----------
ဆောက်လုပ်ထားသောပစ္စည်း----------အိမ်သက်( )နှစ်
ယခုနေရာတွင်နေထိုင်သောသက်တမ်း( )နှစ် (သို့) အစဉ်

B.7. **Your HH land:** (မြေယာပိုင်ဆိုင်မှု)
Residential Land (လူနေအိမ်မြေ)....1.4.....acres
Agricultural land (စိုက်ပျိုးမြေ).....3.0.....acres

B.8 စိမ်ကိန်းနှင့်ပတ်သက်သော မြေယာအငြင်းပွားမှုရှိပါသလား။ ရှိ / မရှိ
ရှိပါက အဘယ်ကြောင့်နည်း ----------
မရှိပါက အဘယ်ကြောင့်နည်း ----------

B.9 စိမ်ကိန်းမှ မြေယာနှင့်ပတ်သက်ပြီး မည်သို့ဖြေရှင်းပေးသနည်း။

B.10 ဖြေရှင်းချက်အပေါ် ကျေနပ်မှု ရှိပါသလား။ ရှိ / မရှိ
ရှိပါက အဘယ်ကြောင့်နည်း ----------
မရှိပါက အဘယ်ကြောင့်နည်း ----------

B.11 မြေယာနှင့်ပတ်သက်သော အကြံပေးချက်ရှိပါက

B.12. ငှါးချမ်းခချောင်းရေသည် ယခင်နှင့်ယခုကွာခြားမှုရှိပါသလား။ ✓ရှိ / မရှိ
မရှိပါက ----------
ရှိပါက ----------

B.13. ငှါးချမ်းခချောင်းရေညစ်ညမ်းမှုကြောင့်ကျန်းမာရေးထိခိုက်မည်ထင်ပါသလား။
မထင်ပါက အဘယ်ကြောင့်နည်း ----------
ထင်ပါကမည်သို့ဆိုသည်ပြောပြပေးပါ ----------

B.14. ငှါးချမ်းခချောင်းသည် ရေလျှံမှုရှိပါသလား ✓ရှိ / မရှိ
မည်သည့်လတွင်ဖြစ်သနည်း။ ----------

Part C Transportation/Movement information (လမ်းပန်းဆက်သွယ်ရေးအချက်အလက်များ)

C.1. မည်သည့်မြို့သို့သွားဘူးသနည်း။
----------( )သွားဘူးသောအကြိမ်

C.2. **Which purposes do your household members uses the alignment for?**
(သွားရောက်သောရည်ရွယ်ချက်)

C.3. **How is your present transportation state in your community?**
(လက်ရှိလမ်းပန်းဆက်သွယ်ရေးအပေါ်ထင်မြင်ချက်)
1. Good (ကောင်း) 2. Normal(ပုံမှန်) 3.Bad (ညံ့)

Part D Opinions upon the Project (စီမံကိန်းပေါ်ထားရှိသောသဘောထားထင်မြင်ချက်)

D.1.Have you heard about the NCK Hydro Power Project? (သိ/မသိ)

☐ 1) No (မသိ) ☐ 2) Yes (သိရှိ)

D.2. From question D.1, if you answer Yes, how do you know the project? (သိရှိပါက)

☐ 1) Informed by authority (အစိုးရထံမှ)

☐ 2) Informed by neighbors (အိမ်နီးနားခြင်းထံမှ)

☑ 3) Informed by media (မီဒီယာများ၊သတင်းစာ၊ဂျာနယ်၊ရေဒီယိုမှသိ)

☐ 4) Informed by Company (ကုမ္ပဏီမှသိ)

D.3. What are your concerns during the project?
(စီမံကိန်းနှင့်ပတ်သက်သော စိုးရိမ်မှု၊ ထင်မြင်ချက်)

Item(အမျိုးအစား)	0 (No) (မကြိုက်)	1 (Less) (သိပ်မကြိုက်)	2 (Normal) (သာမာန်)	3 (Yes) (ကြိုက်)	4 (Very) (အလွန်ကြိုက်)
Overview (အမြင်)	မကြိုက်ကြောင့်				

If No, Why don't you like this project? (စီမံကိန်းအပေါ် မနှစ်သက်ပါက အကြောင်းပြဖြေဆိုပါရန်)

If Yes, Why do you like this project?----------

D.4.Do you feel worried about environmental impact during operational phase of the project?
(စီမံကိန်းနှင့်ပတ်သက်သောပတ်ဝန်းကျင်ဆိုင်ရာအကျိုးသက်ရောက်မှုအပေါ်စိုးရိမ်မှု)

1. No, specify ----------

2. Yes, specify ----------

D.5.Do you feel worried about social impact during operational phase of the project?
(စီမံကိန်းနှင့်ပတ်သက်သောလူမှုဆိုင်ရာအကျိုးသက်ရောက်မှုအပေါ်စိုးရိမ်မှု)

1. No, specify ----------

2. Yes, specify ----------

D.6.Do you feel worried about health impact during operational phase of the project?
(စီမံကိန်းနှင့်ပတ်သက်သောကျန်းမာရေးဆိုင်ရာအကျိုးသက်ရောက်မှုအပေါ်စိုးရိမ်မှု)

1. No, specify ----------

2. Yes, specify ----------

D.7.Do you feel worried about agricultural impact during operational phase of the project?
(စီမံကိန်းနှင့်ပတ်သက်သောစိုးပွားရေးဆိုင်ရာအကျိုးသက်ရောက်မှုအပေါ်စိုးရိမ်မှု)

1. No, specify ----------

2. Yes, specify ----------

D.8. Opinion and Suggestion toward the project Development ----------

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QUESTIONNAIRE FOR HEALTH IMPACT ASSESSMENT OF NGAW CHANG HKA HYDRO POWER PROJECT

ဤမေးခွန်းလွှာသည် ငေါ့ချမ်းခ ရေအားလျှပ်စစ်စီမံကိန်း ပတ်ဝန်းကျင်ကျေးရွာများရှိရွာသူ/သားများ၏ကျန်းမာရေး အခြေအနေများကိုလေ့လာဆန်းစစ်သောမေးခွန်းလွှာဖြစ်ပါသည်။ကူညီဖြေကြားပေးပါရန်မေတ္တာရပ်ခံအပ်ပါသည်။

A.1. ဖြေဆိုသူအမည် ---------[illegible]---------

A.2. (ကျား) / မ

A.3. အသက် (70)နှစ်

A.4. ဘာသာ ☐ ၁.ဗုဒ္ဓဘာသာ ☐ (၂.ခရစ်ယာန်ဘာသာ) ☐ ၃. အခြား

A.5. မိသားစုအရေအတွက် (6)ယောက်☐

A.6. အိမ်ပိုင်ဆိုင်မှု (1. (အိမ်ပိုင်)) 2. (အိမ်ငှား)------------------

A.7. အိမ်အမျိုးအစား - အခင်း/အကာ ---------[illegible]------------------ အမိုး ----[illegible]------

ဆောက်လုပ်ထားသောပစ္စည်း-----------------[illegible]-------------အိမ်သက်တမ်း(7)နှစ်

ယခုနေရာတွင်နေထိုင်သောသက်တမ်း(   )နှစ် (သို့) (ဇာတိ)

B.1. နယ်စပ်ကျော်ဖြတ်၍အလုပ်လုပ်သူရှိပါသလား။ ရှိ / မရှိ (   )ယောက်

B.2. အလုပ်အကိုင် ---------------[illegible]---------------

(မိသားစုတစ်နှစ်ဝင်ငွေ)---[illegible]------- ကျပ် (ဝင်ငွေရရှိသောနေရာ) -----[illegible]------

C.1. သင်၏နေအိမ်တွင် လွန်ခဲ့သော(၆)လအတွင်းရောဂါဖြစ်ဘူးသူရှိပါသလား။ ရှိ (/ မရှိ)

ရှိပါက မည်သည့်ရောဂါနည်း ---------------------------------------

C.2. မကျန်းမာပါကမည်သည့်နေရာသို့သွားရောက်ကုသသနည်း။------[illegible]---------------

မည်သူနှင့်ပြသကုသပါသနည်း။---------------------------

C.3. သင်၏နေထိုင်ရာနေရာတွင် (✓)ပြင်ပဆေးခန်း (ခ)အစိုးရဆေးပေးခန်း (ဂ)အစိုးရဆေးရုံ (ဃ)အခြား

C.4. သင်နေထိုင်ရာနေရာတွင် အခြားလူမှုရေးအဖွဲ့များလာရောက်ဆေးကုသပေးပါသလား။ ကု / မကု

အဖွဲ့အစည်းအမည်နှင့်ကုသနည်းကို ---

D.1 သင်သည်အောက်ပါတို့ကိုသုံးစွဲပါသလား။

သုံးစွဲသည် / မသုံးပါ။

(က)ဆေးလိပ်သောက်ခြင်း (✓ခ)ဘီယာ/အရက် (ဂ)စိတ်ကြွဆေး/မူးယစ်ဆေး

D.2.သောက်သုံးရေကိုမည်သည့်နေရာမှရရှိသနည်း။---[illegible]--------

မည်သည့်ရေကိုသောက်သနည်း။-----------------------------------

မည်သို့သောက်သုံးသနည်း။ (က)ရိုးရိုးရေ (✓ခ)ကျိုချက်ရေ

D.3. အသုံးပြုသောအိမ်သာ

(က)မရှိပါ (ခ)ယင်လုံ (✓ဂ)ယင်မလုံ (ဃ)တောထိုင်သည်

D.4. အမှိုက်များကိုမည်သို့စွန့်ပြစ်သနည်း။မည်သို့လုပ်ဆောင်သနည်း။ ----[illegible]---------

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E. အခြားပြောလိုသောအချက်များရှိပါကပြောပြပေးပါ။-----------------------

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ကျေးဇူးအထူးတင်ရှိပါသည်။

Assessment Done By Interviewer Only

Serial №---2---
Village Tract---Lwelan---
Name of Interviewer---Dr. Ye Naung---

Social economic status	**Satisfactory**	**Unsatisfactory**	**No Comment**
• Education		✓	
• Income		✓	
• Housing	✓		
• Employment	✓		
• Transport		✓	
• Recreation Activity		✓	
• Media		✓	
Population affected	**Risk Present**	**Risk Absent**	**No Comment**
• Under 5		✓	
• Old age		✓	
• Family structure		✓	
• Chronically ill		✓	
• Disables		✓	
Life Style	**Satisfactory**	**Unsatisfactory**	**No Comment**
• Diet	✓		
• Alcohol, tobacco, substance abuse		✓	
• Safe sex behavior			✓
Health care services	**Satisfactory**	**Unsatisfactory**	**No Comment**
• Treatment seeking behavior		✓	
• Health care facilities		✓	
Physical environment	**Satisfactory**	**Unsatisfactory**	**No Comment**
• Water supply	✓		
• Excreta disposal		✓	
• Refuse Disposal		✓	
• Natural Disaster		✓	
• Vectors		✓	
• Vocational Dependency		✓	

③ LP

QUESTIONNAIRE FOR SOCIAL IMPACT ASSESSMENT OF NGAW CHANG HKA HYDRO POWER PROJECT

No .... Date of interview......6.3.14......... Name of interviewee......

Part A Interviewee information (ဖြေဆိုသူ၏အချက်အလက်များ)

A.1. Sex (ကျား/မ) ☐ 1) Male (ကျား) ☑ 2) Female (မ)

A.2. Age (Years) (အသက်/နှစ်) (40)နှစ်

A.3. Religion (ဘာသာ) ☐ 1) Buddhism ☑ 2) Christianity ☐ 3) Others (please specify) ...

A.4. Marital status (အိမ်ထောင်ရှိ/မရှိ)

- ☐ 1) Single (လူလွတ်)
- ☐ 2) Married (အိမ်ထောင်ရှိ)
- ☑ 3) Widowed(မုဆိုးမ)
- ☐ 4) Divorced (ကွာရှင်းထားသူ)

A.5. Level of education(ပညာအရည်အချင်း)

- ☐ 1) No schooling (ကျောင်းမတတ်ဘူးသူ)
- ☑ 2) Primary school (မူလတန်း)
- ☐ 3) Middle school (အလယ်တန်း)
- ☐ 4) High school (အသက်မွေးပညာသင်ကျောင်း)
- ☐ 5) Bachelor Degree (ဘွဲ့ရ)
- ☐ 6) Monastic (ဘုန်းကြီးကျောင်း)

A.6. Occupation (အလုပ်အကိုင်)

- ☐ 1) Unemployed (အလုပ်မရှိသူ)
- ☐ 2) Civil service(အစိုးရဝန်ထမ်း)
- ☑ 3) Agricultural (စိုက်ပျိုးရေး)
- ☐ 4) Fisherman (ငါးဖမ်းသမား)
- ☐ 5) Employed (လစား)
- ☐ 6) Business(စီးပွားရေးလုပ်သူ)
- ☐ 7) Others (အခြား)..

A.7. Race/Indigenous/Family (လူမျိုးစု၊ မျိုးရိုးအမည်)

1) Indigenous Race (လူမျိုးစု) ____________

2) Family (မျိုးရိုးအမည်/မိသားစုအမည် သီးခြားရှိပါက) ____________

Part B Household information (အိမ်ထောင်စု၏အချက်အလက်များ)

B.1. Please give us some brief information about your family: မိသားစုအရေအတွက်

ကျား (5) မ (2) စုစုပေါင်း (7)ယောက်

B.2. Now, what type of living standards is your household in? (အိမ်ထောင်စု၏လူနေမှုအဆင့်)

1. Poor (ဆင်းရဲ) ☑ 2. Normal (အလယ်အလတ်) 3. Well-off (ချမ်းသာ)

B.3. Please let me know your household income sources per year? (မိသားစု၏တစ်နှစ်ဝင်ငွေ) ____________(Kyat) 400000

____________Income sources (ဝင်ငွေရရှိသောနေရာ)

B.4. Please inform your household monthly expenses? (လစဉ်ကုန်ကျငွေ)

1000 ____________ kyats အဝိကကုန်ကျမှု ____________

B.5. What is your household house ownership: (အိမ်ပိုင်ဆိုင်မှု)

✓1. Owned (အိမ်ပိုင်) 2. Rented (အိမ်ငှား)

B.6. အိမ်အမျိုးအစား - အခင်း/အကာ ---------- အိုး ----------

ဆောက်လုပ်ထားသောပစ္စည်း---------- အိမ်သက်(၆)နှစ်

ယခုနေရာတွင်နေထိုင်သောသက်တမ်း(၆)နှစ် (သို့) ဇာတိ

B.7. Your HH land: (မြေယာပိုင်ဆိုင်မှု)

Residential Land (လူနေအိမ်မြေ).....5 ဧက.....acres

Agricultural land (စိုက်ပျိုးမြေ).....5 ဧက.....acres

B.8 စိမ်ကိန်းနှင့်ပတ်သက်သော မြေယာအငြင်းပွားမှုရှိပါသလား။ ရှိ / မရှိ

ရှိပါက အဘယ်ကြောင့်နည်း ----------

မရှိပါက အဘယ်ကြောင့်နည်း ----------

B.9 စိမ်ကိန်းမှ မြေယာနှင့်ပတ်သက်ပြီး မည်သို့ဖြေရှင်းပေးသနည်း။

B.10 ဖြေရှင်းချက်အပေါ် ကျေနပ်မှု ရှိပါသလား။ ရှိ / မရှိ

ရှိပါက အဘယ်ကြောင့်နည်း ----------

မရှိပါက အဘယ်ကြောင့်နည်း ----------

B.11 မြေယာနှင့်ပတ်သက်သော အကြံပေးချက်ရှိပါက

B.12. ငှါးချမ်းခချောင်းရေသည် ယခင်နှင့်ယခုကွာခြားမှုရှိပါလား။ ရှိ / မရှိ

မရှိပါက ----------

ရှိပါက ----------

B.13. ငှါးချမ်းခချောင်းရေညစ်ညမ်းမှုကြောင့်ကျန်းမာရေးထိခိုက်မည်ထင်ပါသလား။

မထင်ပါက အဘယ်ကြောင့်နည်း ----------

ထင်ပါကမည်သို့ဆိုသည်ပြောပြပေးပါ ----------

B.14. ငှါးချမ်းခချောင်းသည် ရေလျှံမှုရှိပါသလား ရှိ / မရှိ

မည်သည့်လတွင်ဖြစ်သနည်း။ ----------

Part C Transportation/Movement information (လမ်းပန်းဆက်သွယ်ရေးအချက်အလက်များ)

C.1. မည်သည့်မြို့သို့သွားသနည်း။ ----------(၁၀)သွားသောအကြိမ်

C.2. Which purposes do your household members uses the alignment for?

(သွားရောက်သောရည်ရွယ်ချက်) ----------

C.3. How is your present transportation state in your community?

(လက်ရှိလမ်းပန်းဆက်သွယ်ရေးအပေါ်ထင်မြင်ချက်)

1. Good (ကောင်း) 2. Normal(ပုံမှန်) ✓3.Bad (ညံ့)

Part D Opinions upon the Project (စီမံကိန်းပေါ်ထားရှိသောသဘောထားထင်မြင်ချက်)

D.1.Have you heard about the NCK Hydro Power Project? (သိ/မသိ)

☐ 1) No (မသိ) ☑ 2) Yes (သိရှိ)

D.2. From question D.1, if you answer Yes, how do you know the project? (သိရှိပါက)

☐ 1) Informed by authority (အစိုးရထံမှ)

☐ 2) Informed by neighbors (အိမ်နီးနားခြင်းထံမှ)

☐ 3) Informed by media (မီဒီယာများ၊သတင်းစာ၊ဂျာနယ်၊ရေဒီယိုမှသိ)

☐ 4) Informed by Company (ကုမ္ပဏီမှသိ)

D.3. What are your concerns during the project?
(စီမံကိန်းနှင့်ပတ်သက်သော စိုးရိမ်မှု၊ ထင်မြင်ချက်)

Item(အချိုးအစား)	0 (No) (မကြိုက်)	1 (Less) (သိပ်မကြိုက်)	2 (Normal) (သာမာန်)	3 (Yes) (ကြိုက်)	4 (Very) (အလွန်ကြိုက်)
Overview (အမြင်)	✓				

If No, Why don't you like this project? (စီမံကိန်းအပေါ် မနှစ်သက်ပါက အကြောင်းပြဖြေဆိုပါရန်)

If Yes, Why do you like this project?---

D.4.Do you feel worried about environmental impact during operational phase of the project?
(စီမံကိန်းနှင့်ပတ်သက်သောပတ်ဝန်းကျင်ဆိုင်ရာအကျိုးသက်ရောက်မှုအပေါ်စိုးရိမ်မှု)

1. No, specify ✓ ---
2. Yes, specify ---

D.5.Do you feel worried about social impact during operational phase of the project?
(စီမံကိန်းနှင့်ပတ်သက်သောလူမှုဆိုင်ရာအကျိုးသက်ရောက်မှုအပေါ်စိုးရိမ်မှု)

1. No, specify ✓ ---
2. Yes, specify ---

D.6.Do you feel worried about health impact during operational phase of the project?
(စီမံကိန်းနှင့်ပတ်သက်သောကျန်းမာရေးဆိုင်ရာအကျိုးသက်ရောက်မှုအပေါ်စိုးရိမ်မှု)

1. No, specify ✓ ---
2. Yes, specify ---

D.7.Do you feel worried about agricultural impact during operational phase of the project?
(စီမံကိန်းနှင့်ပတ်သက်သောစိုးပွားရေးဆိုင်ရာအကျိုးသက်ရောက်မှုအပေါ်စိုးရိမ်မှု)

1. No, specify ✓ ---
2. Yes, specify ---

D.8. Opinion and Suggestion toward the project Development ---

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QUESTIONNAIRE FOR HEALTH IMPACT ASSESSMENT OF NGAW CHANG HKA HYDRO POWER PROJECT

ဤမေးခွန်းလွှာသည် ဝဲ့ချမ်းခ ရေအားလျှပ်စစ်စီမံကိန်း ပတ်ဝန်းကျင်ကျေးရွာများရှိရွာသူ/သားများ၏ကျန်းမာရေး အခြေအနေများကိုလေ့လာဆန်းစစ်သောမေးခွန်းလွှာဖြစ်ပါသည်။ကူညီဖြေကြားပေးပါရန်မေတ္တာရပ်ခံအပ်ပါသည်။

A.1. ဖြေဆိုသူအမည် ---------

A.2. ကျား / မ

A.3. အသက် (၅၀)နှစ်

A.4. ဘာသာ □ ၁.ဗုဒ္ဓဘာသာ □ ၂.ခရစ်ယာန်ဘာသာ □ ၃. အခြား

A.5. မိသားစုအရေအတွက် (၇)ယောက်□

A.6. အိမ်ပိုင်ဆိုင်မှု 1. (အိမ်ပိုင်) 2. (အိမ်ငှား)---------

A.7. အိမ်အမျိုးအစား - အခင်း/အကာ ---------- အမိုး ----------

ဆောက်လုပ်ထားသောပစ္စည်း----------အိမ်သက်တမ်း(၆)နှစ်

ယခုနေရာတွင်နေထိုင်သောသက်တမ်း( )နှစ် (သို့) ကတိ

B.1. နယ်စပ်ကျော်ဖြတ်၍အလုပ်လုပ်သူရှိပါသလား။ ရှိ / မရှိ (|)ယောက်

B.2. အလုပ်အကိုင် ----------

(မိသားစုတစ်နှစ်ဝင်ငွေ)---------- ကျပ် (ဝင်ငွေရရှိသောနေရာ) ----------

C.1. သင်၏နေအိမ်တွင် လွန်ခဲ့သော(၆)လအတွင်းရောဂါဖြစ်ဘူးသူရှိပါသလား။ ရှိ / မရှိ

ရှိပါက မည်သည့်ရောဂါနည်း ----------

C.2. မကျန်းမာပါကမည်သည့်နေရာသို့သွားရောက်ကုသသနည်း။----------

မည်သူနှင့်ပြသကုသပါသနည်း။----------

C.3. သင်၏နေထိုင်ရာနေရာတွင် (၄)ပြင်ပဆေးခန်း (ခ)အစိုးရဆေးပေးခန်း (ဂ)အစိုးရဆေးရုံ (ဃ)အခြား

C.4. သင်နေထိုင်ရာနေရာတွင် အခြားလူမှုရေးအဖွဲ့များလာရောက်ဆေးကုသပေးပါသလား။ ကု / မကု

အဖွဲ့အစည်းအမည်နှင့်ကုသနည်းကို ----------

D.1 သင်သည်အောက်ပါတို့ကိုသုံးစွဲပါသလား။

သုံးစွဲသည် / မသုံးပါ။

(က)ဆေးလိပ်သောက်ခြင်း (ခ)ဘီယာ/အရက် (ဂ)စိတ်ကြွဆေး/မူးယစ်ဆေး

D.2.သောက်သုံးရေကိုမည်သည့်နေရာမှရရှိသနည်း။----------

မည်သည့်ရေကိုသောက်သနည်း။----------

မည်သို့သောက်သုံးသနည်း။ (က)ရိုးရိုးရေ (ခ)ကျိုချက်ရေ

D.3. အသုံးပြုသောအိမ်သာ

(က)မရှိပါ (ခ)ယင်လုံ (ဂ)ယင်မလုံ (ဃ)တောထိုင်သည်

D.4. အမှိုက်များကိုမည်သို့စွန့်ပြစ်သနည်း။မည်သို့လုပ်ဆောင်သနည်း။ ----------

E. အခြားပြောလိုသောအချက်များရှိပါကပြောပြပေးပါ။----------

ကျေးဇူးအထူးတင်ရှိပါသည်။

Assessment Done By Interviewer Only

Serial №---3---
Village Tract---Lone Pon---
Name of Interviewer---Dr. Ye Naing---

Social economic status	Satisfactory	Unsatisfactory	No Comment
• Education		✓	
• Income	✓		
• Housing	✓		
• Employment	✓		
• Transport		✓	
• Recreation Activity		✓	
• Media		✓	
Population affected	**Risk Present**	**Risk Absent**	**No Comment**
• Under 5		✓	
• Old age		✓	
• Family structure		✓	
• Chronically ill		✓	
• Disables		✓	
Life Style	**Satisfactory**	**Unsatisfactory**	**No Comment**
• Diet	✓		
• Alcohol, tobacco, substance abuse		✓	
• Safe sex behavior			✓
Health care services	**Satisfactory**	**Unsatisfactory**	**No Comment**
• Treatment seeking behavior		✓	
• Health care facilities		✓	
Physical environment	**Satisfactory**	**Unsatisfactory**	**No Comment**
• Water supply	✓		
• Excreta disposal		✓	
• Refuse Disposal		✓	
• Natural Disaster		✓	
• Vectors		✓	
• Vocational Dependency		✓	

9 (23) (1)

QUESTIONNAIRE FOR SOCIAL IMPACT ASSESSMENT OF NGAW CHANG HKA HYDRO POWER PROJECT

No .... Date of interview........................ Name of interviewee..[illegible]..

Part A Interviewee information (ဖြေဆိုသူ၏အချက်အလက်များ)

A.1. Sex (ကျား/မ) ☐ 1) Male (ကျား) ☐ 2) Female (မ)

A.2. Age (Years) (အသက်/နှစ်) (62)နှစ်

A.3. Religion (ဘာသာ) ☐ 1) Buddhism ☐ 2) Christianity ☐ 3) Others (please specify)

A.4. Marital status (အိမ်ထောင်ရှိ/မရှိ)

☐ 1) Single (လူလွတ်) ☐ 2) Married (အိမ်ထောင်ရှိ)

☐ 3) Widowed(မုဆိုးမ) ☐ 4) Divorced (ကွာရှင်းထားသူ)

A.5. Level of education(ပညာအရည်အချင်း)

☐ 1) No schooling (ကျောင်းမတက်ဘူးသူ) ☐ 2) Primary school (မူလတန်း) ☐ 3) Middle school (အလယ်တန်း)

☐ 4) High school (အသက်မွေးပညာသင်ကျောင်း) ☐ 5) Bachelor Degree (ဘွဲ့ရ) ☐ 6) Monastic (ဘုန်းကြီးကျောင်း)

A.6. Occupation (အလုပ်အကိုင်)

☐ 1) Unemployed (အလုပ်မရှိသူ) ☐ 2) Civil service(အစိုးရဝန်ထမ်း)

☐ 3) Agricultural (စိုက်ပျိုးရေး) ☐ 4) Fisherman (ငါးဖမ်းသမား)

☐ 5) Employed (လစား) ☐ 6) Business(စီးပွားရေးလုပ်သူ)

☐ 7) Others (အခြား)...

A.7. Race/Indigenous/Family (လူမျိုးစု၊ မျိုးရိုးအမည်)

1) Indigenous Race (လူမျိုးစု) [illegible]

2) Family (မျိုးရိုးအမည်/မိသားစုအမည် သီးခြားရှိပါက) [illegible]

Part B Household information (အိမ်ထောင်စု၏အချက်အလက်များ)

B.1. Please give us some brief information about your family: မိသားစုအရေအတွက် ကျား (3) မ (2) စုစုပေါင်း (5)ယောက်

B.2. Now, what type of living standards is your household in? (အိမ်ထောင်စု၏လူနေမှုအဆင့်)

1. Poor (ဆင်းရဲ) 2. Normal (အလယ်အလတ်) 3. Well-off (ချမ်းသာ)

B.3. Please let me know your household income sources per year? (မိသားစု၏တစ်နှစ်ဝင်ငွေ)

စိုက်ပျိုးရေး Income sources (ဝင်ငွေရရှိသောနေရာ) [illegible] (Kyat)

B.4. Please inform your household monthly expenses? (လစဉ်ကုန်ကျငွေ)

[illegible] 80000 kyats အဓိကကုန်ကျမှု [illegible]

B.5. What is your household house ownership: (အိမ်ပိုင်ဆိုင်မှု)

(1.) Owned (အိမ်ပိုင်) 2. Rented (အိမ်ငှား)

B.6. အိမ်အမျိုးအစား - အခင်း/အကာ ---------- အမိုး ----------

အောက်လုပ်ထားသောပစ္စည်း ---------- အိမ်သက်( ) နှစ်

ယခုနေရာတွင်နေထိုင်သောသက်တမ်း( ) နှစ် (သို့) ဈေးတို့

B.7. Your HH land: (မြေယာပိုင်ဆိုင်မှု)

Residential Land (လူနေအိမ်မြေ).....acres

Agricultural land (စိုက်ပျိုးမြေ).....acres

B.8 စီမံကိန်းနှင့်ပတ်သက်သော မြေယာအငြင်းပွားမှုရှိပါသလား။ ရှိ / (မရှိ)

ရှိပါက အဘယ်ကြောင့်နည်း ----------

မရှိပါက အဘယ်ကြောင့်နည်း ----------

B.9 စီမံကိန်းမှ မြေယာနှင့်ပတ်သက်ပြီး မည်သို့ဖြေရှင်းပေးသနည်း။ ----------

B.10 ဖြေရှင်းချက်အပေါ် ကျေနပ်မှု ရှိပါသလား။ ရှိ / (မရှိ)

ရှိပါက အဘယ်ကြောင့်နည်း ----------

မရှိပါက အဘယ်ကြောင့်နည်း ----------

B.11 မြေယာနှင့်ပတ်သက်သော အကြံပေးချက်ရှိပါက ----------

B.12. ငှါးချမ်းခချောင်းရေသည် ယခင်နှင့်ယခုကွာခြားမှုရှိပါလား။ (ရှိ) / (မရှိ)

မရှိပါက ----------

ရှိပါက ----------

B.13. ငှါးချမ်းခချောင်းရေညစ်ညမ်းမှုကြောင့်ကျန်းမာရေးထိခိုက်မည်ထင်ပါသလား။ ----------

မထင်ပါက အဘယ်ကြောင့်နည်း ----------

ထင်ပါကမည်သို့ဆိုသည်ပြောပြပေးပါ ----------

B.14. ငှါးချမ်းခချောင်းသည် ရေလျှံမှုရှိပါသလား ရှိ / (မရှိ)

မည်သည့်လတွင်ဖြစ်သနည်း။ ----------

Part C Transportation/Movement information (လမ်းပန်းဆက်သွယ်ရေးအချက်အလက်များ)

C.1. မည်သည့်မြို့သို့သွားဘူးသနည်း။ ---------- ( )သွားဘူးသောအကြိမ်

C.2. Which purposes do your household members uses the alignment for?

(သွားရောက်သောရည်ရွယ်ချက်) ----------

C.3. How is your present transportation state in your community?

(လက်ရှိလမ်းပန်းဆက်သွယ်ရေးအပေါ်ထင်မြင်ချက်)

(1.) Good (ကောင်း) 2. Normal(ပုံမှန်) 3.Bad (ညံ့)